الجمهورية الجزائرية الديمقراطيةالشعبية

Ministry Of Higher Education and Scientific Research

IBN KHALDOUN university –Tiaret-

Faculty of Natural Sciences and Life

Department of Nutrition and Agri-Food Technologies

3rd cycle doctoral thesis (L.M.D)

Option : Animal Production

Theme

A COMPARATIVE STUDY OF DIFFERENT TYPES OF COW'S MILK MARKETED IN TIARET REGION

Presented by :

BELKHEMAS AMINA

Under the Supervision of : Pr NIAR Abdelatif

Approved by :

- **President :**	Mrs MELIANI Samia (Professor)	University of Tiaret
- **Thesis director** :	Mr NIAR Abdelatif (Professor)	University of Tiaret
- **Co-director** :	Mr BENALLOU Bouabdellah (Professor)	University of Tiaret
- **Examiners** :	Mrs ZIDANE Azdinia (Associate Professor A)	University of Chlef
	Mr TAHERTI Mourad (Associate Professor A)	University of Chlef
	Mr ABDELHADI Si Ameur (Professor)	University of Tiaret

2022-2023

ACKNOWLEDGMENT

First and foremost, I am grateful to the Almighty Allah, the most beneficent, for his graciousness bestowed upon me and the power he has given me to accomplish this dissertation.

My deepest thanks and recognition are extended to my supervisor, **Pr. Niar Abdellatif**, for his invaluable supervision, helpful suggestions, and continuous encouragement.

There are no words to adequately express my heartfelt gratitude and appreciation to my co-supervisor, **Pr. Benallou Bouabdellah**, for his keen supervision, deep interest, and valuable advice and guidance.

My appreciation also extends to the jury members: **Mrs MELIANI Samia, Mrs ZIDANE Azdinia, Mr TAHERTI Mourad** and**, Mr ABDELHADI Si Ameur** for approving the evaluation of this work.

I would like to take this opportunity to express my gratitude to all members of the farm Animal Reproduction Laboratory at the Veterinary Institute and to thank all the farm owners from which I collected samples for this investigation.

Finally, I would like to thank my family and friends for their unlimited support and continuous encouragement to complete this study.

DEDICATION

I dedicate this modest work:

To my dear parents, no dedication could express my appreciation, my respect, and my deep emotions towards them.

To my lovely sisters and dear brothers, who supported me throughout the course of this work.

To all of my close friends and colleagues.

To everyone who supports and loves me.

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

C°: Celsius degree.

EC: Electrical conductivity.

HTST: high-temperature short time.

LTST: low-temperature short time.

MY: Milk Yield.

pH: potential Hydrogen.

SEC: Seconde.

SNF: Solids Not Fat.

TS: total solids

UHT: ultra-high temperature treatment.

TABLE OF CONTENTS

ABSTRACT

The first objective of the current research was to determine the influence of season and stage of lactation on the physico-chemical characteristics of imported crossbred dairy cows in Tiaret city (Algerian West High Lands). A total of 557 raw individual milk samples from fifty cows were collected and analyzed by ultrasonic milk analyzer "Lactoscan SP", over four seasons and at various stages of lactation (early, mid, and late). The physicochemical investigated parameters include fat, protein, minerals, lactose, solids not fat, total solids, pH, conductivity, density and freezing point. The overall findings revealed a wide variation in milk chemical composition by season. Winter milk had higher levels of the main components of cow's milk (solids not fat: 96.4±0.04 g/l, protein: 35.3±0.01 g/l, minerals: 7.8±0.04 g/l, and lactose: 53±0.02 g/l). Moreover, the physical parameters also varied greatly depending on the season of the year. The highest conductivity 5.29±0.04 (µS cm^{-1}) and density 1.0346±0.29 (kg/l) were registered during the summer. On the other hand, the physico-chemical features showed less variability depending on the stage of lactation. However, both fat and conductivity were significantly affected by this factor ($p \leq 0.05$).

The second objective of this work was to compare the physicochemical properties of three different types of whole milk (raw, pasteurized, and UHT) commercialized in Tiaret city. A total of 290 milk samples were analyzed, including 140 raw mixed milk samples collected from the "SIDI KHALED" dairy and 90 random samples of processed whole milk (60 UHT milk and 30 pasteurized milk), obtained from various points of sale. The comparative analysis of the different kinds of milk revealed significant variations in almost all of the physico-chemical properties examined, with the exception of the density ($p>0.05$). Furthermore, raw milk contained more nutritional components (fat: 34.2±0.04 g/l, solids not fat: 86.8±0.03 g/l, protein: 32±0.02 g/l, minerals: 7±0.003g/l, lactose: 47.7±0.01 g/l and total solids 121.2±0.05 g/l) than pasteurized and sterilized milk, which could be a result of poor storage conditions and the heat treatment effect.

Key words: physicochemical characteristics, Tiaret, crossbred cows, season, stages of lactation, raw milk, processed milk.

RESUMÉ

Le premier objectif de cette recherche était de déterminer l'influence de la saison et du stade de lactation sur les caractéristiques physico-chimiques des vaches laitières croisées importées dans la ville de Tiaret (Haute-Terres de l'Ouest algérien). Au total, 557 échantillons individuels de lait cru de cinquante vaches ont été prélevés et analysés par l'analyseur de lait Lactoscan SP sur quatre saisons et à divers stades de la lactation (début, milieu et fin). Les paramètres physicochimiques étudiés comprennent la matière grasse, les protéines, les minéraux, le lactose, l'extrait sec dégraissé, les solides totaux, le pH, la conductivité, la densité et le point de congélation. Les résultats globaux ont révélé une grande variation de la composition chimique du lait par saison. Le lait d'hiver avait des niveaux plus élevés des principaux composants du lait de vache (extrait sec dégraissé : 96,4±0,04 g/l, protéines : 35,3±0,01 g/l, minéraux : 7,8±0,04 g/l et lactose : 53±0,02 g/l). De plus, les paramètres physiques variaient grandement selon la saison de l'année. La conductivité la plus élevée 5,29±0,04 ($\mu S\ cm^{-1}$) et la densité la plus élevée 1,0346±0,29 (kg/l) ont été enregistrées pendant l'été. En revanche, les caractéristiques physico-chimiques ont montré moins de variabilité selon les stades de lactation. Cependant, la matière graisse et la conductivité ont été significativement affectée par ce facteur ($p \leq 0.05$).

Le deuxième objectif de ce travail était de comparer les propriétés physico-chimiques de trois différents types de lait entier (cru, pasteurisé et UHT) commercialisé dans la ville de Tiaret. Au total, 290 échantillons de lait ont été analysés, dont 140 échantillons de lait mélangé cru provenant de la laiterie "SIDI KHALED" et 90 échantillons aléatoires de lait entier transformé (60 laits UHT et 30 laits pasteurisés) provenant de divers points de vente. L'analyse comparative des différents types de lait a révélé des variations significatives dans la majeure partie des propriétés physicochimiques examinées, à l'exception de la densité ($p > 0.05$). En outre, le lait cru inclus plus d'éléments nutritifs (matière grasse : 34.2±0.04 g/l, extrait sec dégraissé : 86.8±0.03 g/l, protéines : 32±0.02 g/l, minéraux : 7±0.003g/l, lactose : 47.7±0.01 g/l et les solides totaux : 121.2±0.05 g/l) comparativement au lait pasteurisé et au lait stérilisé, ce qui pourrait être le résultat de mauvaises conditions de stockage et probablement surtout à l'effet du traitement thermique.

Mots clés : caractéristiques physicochimiques, Tiaret, vaches croisées, saison, stades de lactation, lait cru, lait transformé.

الملخص

الهدف الأول من البحث الحالي هو تحديد تأثير الموسم ومراحل الإرضاع على الخصائص الفيزيائية والكيميائية للأبقار الحلوب المهجنة المستوردة في مدينة تيارت (الأراضي المرتفعة الغربية الجزائرية). تم جمع 557 عينة من الحليب الفردي الخام من خمسين بقرة، وتحليلها بواسطةجهاز Lactoscan SPعلى مدى أربعة مواسم وفي مراحل مختلفة من الرضاعة (المبكرة، المتوسطة والمتأخرة). تشمل المعاييرالفيزيائية والكيميائية التي تم فحصها: الدهون، البروتين، المعادن، اللاكتوز، المواد الصلبة غير الدهنية، المواد الصلبة الكلية، الحموضة، الناقلية، الكثافة، ونقطة التجمد. كشفت النتائج الإجمالية عن اختلاف كبير في التركيب الكيميائي للحليب حسب الموسم، حيث يحتوي حليب الشتاء على مستويات أعلى من المكونات الرئيسية لحليب البقر (المواد الصلبة غير الدهنية: 96,4±0,04 غ/ل، البروتين: 35,3±0,01 غ/ل، الأملاح: 84±0,04 غ/ل، واللاكتوز: 53±0,02 غ/ل). علاوة على ذلك، تختلف المعايير الفيزيائية أيضًا بشكل كبير اعتمادًا على الموسم حيث تم تسجيل أعلى قيمة للناقلية 5,29±0,04 (µS cm-1) والكثافة 1,0346±0,29 (كغ/ل) خلال فصل الصيف. من ناحية أخرى، أظهرت الخصائص الفيزيائية والكيميائية تباينًا أقل، وذلك اعتمادًا على مراحل الرضاعة. ومع ذلك، تأثرت كلاً من الدهون والناقلية تأثرا كبير بهذا العامل ($p \leq 0.05$).

وكان الهدف الثاني من هذا العمل هو مقارنة الخصائص الفيزيائية والكيميائية لثلاثة أنواع مختلفة من الحليب كامل الدسم (الخام،المبستر والمعقم) المسوق في مدينة تيارت، حيث تم تحليل 290 عينة حليب، بما في ذلك 140 عينة من الحليب الخام الممزوج والتي تم جمعها بملبنة "سيدي خالد"،و90 عينة عشوائية من الحليب كامل الدسم (60 عينة حليب معقم و30 عينة حليب مبستر) والتي تم اقتناءها من عدة نقاط بيع مختلفة.كشف التحليل المقارن للأنواع المختلفة من الحليب عن اختلافات كبيرة في كل الخصائص الفيزيائية والكيميائية التي تم فحصها، باستثناء الكثافة ($p>0.05$). إضافة إلى ذلك، كان الحليب الخام غنيا بالمكونات الغذائية (الدهون: 34,2±0,04 غ/ل، المواد الصلبة غير الدهنية: 86,8±0,03 غ/ل، البروتين: 32±0,02 غ/ل، الأملاح: 7±0,003 غ/ل، اللاكتوز: 47,72±0,01 غ/ل، والمواد الجافة: 121,2±0,05 غ/ل) مقارنة بالحليب المبستر والحليب المعقم، والذي قد يكون نتيجة لظروف التخزين السيئة وتأثير المعالجة الحرارية.

الكلمات المفتاحية: الخصائص الفيزيائية والكيميائية، تيارت، الابقار الهجينة، الموسم، مراحل الرضاعة، الحليب الخام، الحليب المصنع.

INTRODUCTION

INTRODUCTION

Algeria is the Maghreb's largest milk consumer and the world's second largest importer after China **(Mansor, 2015).** More over, the annual production of raw milk is estimated at 3.5 billion liters with an annual importation of 1.5 to 2 billion liters, while consumption is anticipated to be greater than 5.5 billion liters per year **(MADRP, 2015).**

Milk is an essential nutrient source for both humans and animals (**Kanyeka, 2014**). In addition, this food is a practically complete diet that is considered to be the first and only nourishment for mammalian youngs **(Pandey and Voskuil, 2011).** It is an aqueous complex combination of proteins, lactose, lipids, vitamins, and minerals (**Senter, 1970).** Fat occurs in the form of an emulsion, proteins are in colloidal solution, minerals and lactose are in true solution (**Senter, 1970).**

Bovine milk contains around 2.8–3.5 % protein, 3.5–5% fat, 0.7% salts, 4.5–5% lactose, and the rest is water (**Harsted and Steinshamn, 2010 ; Kelly and Larsen, 2010).** This composition varies according to the nutritional status, the breed, the species, age, health, lactation stage, and other factors **(Fox and Mc Sweeney, 1998).**

In terms of food and nutrition safety, consumers typically require safe and high-quality milk and dairy products **(Ayza *et al*., 2013)**. For these reasons, different heat treatment processes were developed to produce a healthy and microbiologically safe product **(Claeys *et al*., 2013).**

The main purpose of thermal processingof milk is to increase the shelf life and enhance the quality of this complex food by lowering the microbial population and there by reducing the risk of food poisoning **(Mc Kinnon *et al*., 2009).** In this context, various techniques are used like pasteurization and sterilization (Ultra High Temperature) (**Inagaki *et al*., 2017).**

Pasteurization is a considerably mild heat treatment that destroys all the harmful bacteria present in raw milk and inactivates the enzymes obtained from the milk. However, sterilization is a more intense heat treatment that aims to kill all contaminating germs (**Inagaki *et al* ., 2017).**

Fortunately, the UHT treatment gives items a shelf life of six months to a year without needing refrigeration, allowing them to be distributed even in areas with underdeveloped cold-chain systems or across long distances (**Malmgren, 2007), i**n contrast to pasteurized milk, which should be consumed inside of seven days after being produced (**Dey *et al*., 2013).**

Nonetheless, the main practical problem is that heat treatments have an impact on the milk's content **(Griffiths, 2010).** The higher temperature has an effect on lipids, minerals, carbohydrates, and proteins, but not on the total nutritional content of the milk (**Hagsten, 2016).**

As a result of the abundance of milk on the market, consumers have become more selective about the quality of milk. This increased demand for quality milk puts additional pressure on farmers to ensure that they have management strategies in place to satisfy milk quality demands (**Nolan, 2020).**

There are various common methods to determine the nutritional quality of milk, such as physical and chemical analysis. Further**,** analytical chemistry is one of the most effective methods for describing food in both qualitative and quantitative terms **(De Vries and Silvera, 2000)**. It isused not only for the examination of the food itself, but also to monitor the effects of food after it has been produced (**Chotyakul, 2014).**

In fact, knowledge and application of milk's physico-chemical properties are widely considered to be a good way to improve milk processing and the dairy industry in general **(Neba, 2015).** For these reasons, milk's chemistry and physicochemical features have been investigated for approximately 200 years and are now, wellknown and detailed in extensive literature (**Boland and Singh, 2019).**

In this regard, we have established the following goals:

- ✓ To determine the physico-chemical component of milk produced by cross-bred cows in Tiaret city (Algeria).
- ✓ To illustrate and comprehend seasonal fluctuations in the properties of raw milk.
- ✓ To analyze and compare the physico-chemical properties of cow milk during different lactation stages (early, mid, and late).
- ✓ To examine the quality of the chosen commercial (pasteurized and UHT) milk purchased from Tiaret city markets through out the year.
- ✓ To compare the physico-chemical properties of raw, pasteurized and UHT milk.

Another purpose:

- ✓ To raise public awareness about the quality of milk they consume on a daily basis.
- ✓ To provide an overview of raw milk quality for milk processing businesses.

LITERATURE REVIEW

Chapter I:

RAW MILK

I. Milk composition

Milk is a good source of dietary protein and lipids as well as supporting immunological, nutritional, and developmental elements of childhood (**O'Callaghan *et al.*, 2019).** It is essentially a dilute salt solution with vitamins and simple sugar, in which fat globules are emulsified, and this comprises a complex protein system, the majority of which are found in colloidal aggregation comprising thousands of molecules (micelles of casein) **(Griffiths, 2010).**

All mammalian milk has similar fundamental components like moisture, carbohydrates, proteins, lipids, minerals, and vitamins. However, milk constituent proportions vary greatly among non-ruminant and ruminant species **(Claeys *et al*., 2014).** Bovine milk has an average carbohydrate content of 4.8%, 3.7% fat, 3.4% protein, and 0.7% small molecular weight substances **(Fox and Mc Sweeney, 1998).**

Milk composition is crucial for both nutritional benefit and processability **(Walstra *et al.*, 2006).** Furthermore, the quality of raw milk is a fundamental factor in evaluating the dairy industry's performance **(Srari *et al.*, 2009).**

I.1. Chemical composition

Milk content is classified as either originary or non-originary, with originary constituents including water, minerals, proteins, lactose, lipids, enzymes, and vitamins, and non-originary elements include cells, chemicals, microorganisms, and others **(Osman, 2006).**

Raw milk's general components are represented in **Table 01**.

Table 01. Contents of standard raw milk **(Walstra and Jenness, 1984).**

Component	Level in milk (%)
Water	87.3
Fat	3.9
Protein	3.25
Caseinprotein	2.6
Wheyprotein	0.75
Lactose	4.6
Minerals	0.65
Organicacids	0.18

I.1.1. Water

Water is a fundamental constituent of milk; it's the medium where all of the substances are in suspension or in solution **(Osman, 2017; Rakib, 2013).** Additionally, water is present in milk in two forms: free water (96%) and bound water (4%), and it is coupled with phospholipids, fat globules, and proteins **(Osman, 2017).**

Cow milk generally has 86–87% of water, whereas water content varies between cows depending on breed **(Osman, 2017).**

I.1.2. Fat

Fox (2009) notes that milk fat is highly complicated and occurs in a unique emulsion**.** It is the most abundant component in milk after water **(Griffiths, 2010).** As fats have a caloric density that is really two and half times greater than lactose, the primary role of nutritional lipids is to provide energy to the newborn **(Boland, 2019).**

Chemically, milk lipids are made of around 25 distinct fatty acids mixed with glycerol to generate a variety of diverse neutral fats like palanitin, stearin, and olein (**Rakib, 2013).** These fatty acids (particularly linoleic acid, C18:2) and vitamins soluble in fat (A, D, E, K) cannot be produced by higher animals **(Sundekilde, 2012).** Milk fat also includes carotenes, which makes the color of milk to be golden (reddish yellow) **(Bennett *et al.*, 1965).** The chemical characteristics of fatty acids have significant implications for both milk's nutritive value (in terms of the health or otherwise of saturable fats) and its technological features (refrigeration temperature) (**Griffiths, 2010).**

Cow milk fat is digestible and includes a high proportion of free fatty acids with a short chain, 4% of necessary fatty acids and fat-soluble vitamins, and 10% to 30% of fatty acids with a long chain **(Osman, 2017).**

I.1.3. Proteins

The protein content in milk has a considerable impact on the quality and yield of dairy products, especially for cheese **(Walstra *et al.*, 2005).** However, proteins have the greater influence on the features of milk and the majority of dairy products than any other component **(Boland, 2019).**

Milk proteins are divided into two categories: caseins and whey proteins, which account for around 80% and 20% of the protein composition in milk, respectively **(Dalgleish, 1993)**. The type and number of proteins differ considerably between species **(Riet Sapriza, 2007**).

The characteristics of casein and whey proteins differed greatly, particularly their solubility if the milk's pH was set to 4.6 **(Fox *et al.*, 2015)**. Casein is considered as a complete protein that is water-insoluble and exclusively found in milk (**Rakib, 2013)**. Furthermore, in the milk's aqueous environment, caseins form highly complicated structures called micelles, which contain hundreds of molecules of each casein **(Fox and Kelly, 2004).** The principal role of casein is nutritive, as it is an amino acid supply (**Riet Sapriza, 2007).**

Whey proteins make up roughly 20% of milk's protein content (**Brooksbank, 1993).** Alpha-lactalbumin and beta-lactoglobulin are the two main proteins found in whey proteins, with a minor fraction made up of serum albumin and immunoglobulins **(Patton, 2004).**

According to **Osman (2017),** cow's milk proteins are classified as follows: lactoalbumin, B-lactoglobulin, and casein, which comprise about 90-95 percent of the overall proteins.

I.1.4. Lactose

Lactose is a milk sugar constituted of galactose and glucose sugar units, linked together **(Patton, 2004).** It is less water soluble, sweeter than sucrose, and fermented with bacteria to produce lactic acid **(Griffiths, 2010).** Further, lactose is a necessary component in the fermentation of dairy products, which is one of the methods used to preserve milk **(Fox and Mc Sweeney, 1998; Nero *et al.*, 2018).**

Milk has 4.8% lactose **(Fox and Mc Sweeney, 1998).** The lactose level in milk is typically stable and has an impact on milk output, because lactose is synthesized by the udder and controls how much water is absorbed into the milk **(Griffiths, 2010).**

I.1.5. Minerals

When compared to lipids or proteins, minerals make only a minor portion of milk, but they play a crucial function in casein micelles' shape and stability (**Nero *et al.*, 2018).** They are present as metallic elements (Calcium, sodium, magnesium, potassium, copper, manganese and iron), and non metallic compounds like phosphorus, chlorine, and sulphur **(Jai, 2014).** Sodium, magnesium, calcium are the main cations in the salt portion, whereas inorganic citrate, phosphate and chloride are the major anions **(Gaucheron, 2005).**

In addition, inorganic phosphate, calcium and other minerals are dispersed between colloidal phases (micelles of casein) and the soluble phase, and their distribution is affected by temperature, pH and concentration, among many others parameters **(Lucey and Horne, 2009).**

Minerals in cow's milk are estimated to account for 0.6–0.8% of the overall composition of the milk and are converted to ash during milk analysis (**Osman, 2017).** Moreover, cow's milk has seven minerals as major components, and their concentrations can vary greatly **(Harper, 1981).**

According to **Osman (2017)**, the typical percentages of the major minerals in the overall composition were potassium 0.15%, calcium 0.120%, phosphorus 0.10%, chlorine 0.11%, sodium 0.05%, and manganese 0.01%.

Minerals, with their biological activities, buffer capacity, and colligative characteristics, play an important role in the production and stability of casein micelles **(Lucey and Horne, 2009**). Both the minerals found in high concentrations and the trace minerals, play vital roles in bone formation and development, cell function, and osmolarity preservation (**Lucey and Horne, 2009).** In dairy production, minimal changes in the physicochemical process conditions might cause composition alterations or salt partitioning, affecting casein micelle stability **(Nero *et al.*, 2018).**

I.2. Physical Properties

The freezing point, boiling point, specific gravity, and color are the most essential physical properties of milk (**Rakib, 2013)**.They are comparable to the properties of water (**Nero *et al.*, 2018**).

Additionally, physical milk characteristics are interesting because they can influence the design and operation of dairy process technology, such as thermal conductivity or viscosity, or they can be used to identify the amount of a specific constituent in milk, such as using a change in freezing point to forecast added water, or they can be used to assess the extent of biochemical modifications that occur during processing (e.g acidification) **(Fox and Mc Sweeney, 1998).**

I.2.1. Freezing Point

Milk froze at a temperature lower than ordinary water, having a freezing point between -0.525 C° and -0.565 C° **(Osman, 2017).**

This feature is used as a legal test for determining if bovine milk has been diluted with water **(Neville, 1995),** because the freezing point is lowered when soluble water is present **(Bundelkhand, 2011).**

I.2.2. Electrical conductivity

The electrical conductivity of milk is used to check cows for probable subclinical mastitis, and varieties of portable devices are commercially available for this purpose (**Fascar *et al.*, 1992; Hillerton *et al*., 1991 and Lansbergen *et al.*, 1994).**

The normal conductivity of cow milk varies between 4 and 5.8 mS and is affected by age, stage of lactation, milking interval, and animal race **(Nielen *et al*., 1992; Walzel 1997; Billon *et al.*, 2001)**. Ions (especially Na+, Cl-, and K+) account for the majority of the electrical conductivity of milk, which is raised by bacterial lactose fermentation to lactic acid **(Griffiths, 2010).**

I.2.3. pH

Milk acidity, defined as pH or titratable acidity, is an essential property (**Rakib, 2013).** Regular milk has a pH of around 6.5–6.8 **(Kanwal *et al.*, 2004; Enb *et al.*, 2009).** However, the pH of milk decreases during the heating process rises slightly in mastitis milk, late lactation and during storage related to CO_2 loss **(Tsioulpas *et al.*, 2007; Jai, 2014).**

Moreover, pH milk can affect a variety of quality factors, including the milk's colloid stability and other heat-induced processes like lactulose production and Maillard browning (**Rakib, 2013).**

II. Factors affecting milk's physico-chemical quality

Since the composition of milk is not constant, it poses many obstacles to the dairy product manufacturers **(Griffiths, 2010)**. This variance is influenced by a mix of environmental and genetic variables such as age, stage of lactation, diet, health state, and the climatic circumstances **(Fox and Mc Sweeney, 1998).**

II.1. Seasonal variation

Variations in milk components, as well as lipid content, have been demonstrated to follow seasonal changes **(Lock and Garnsworthy, 2003).**

In general, milk has a greater protein and fat level in the fall and winter, while the spring and summer months have the lowest level for these two components **(Jai, 2014).**

It is difficult to decide on this information since the seasonal change is caused by an amalgam of many causes **(Fox and Cogan, 2004).**

II.2. Stage of lactation

Instantly after parturition, the mammary gland secretes the colostrum, which is high in nutrients that are required in the early days of life **(Griffiths, 2010).** The colostrum period lasts approximately 48–72 hours, after which the production assumes a constitution more typical of milk **(Madsen *et al*., 2004)**, and the next weeks may be called early lactation, which transitions to the stage of mid-lactation, when milk supply is at its peak and milk processing features are normally at their best **(Griffiths, 2010).**

Milk fat, protein, and lactose content fluctuate according to the stage of lactation, with lipids and SNF percentages being greater in the early weeks of postpartum, reducing in the third month, and then increasing again when milk yield progressively decreases **(O'Mahony, 1998).** In addition, the total calcium concentrations are generally high in both late and early lactation; however, there does not appear to be any correlation with the stage of lactation during the intermediate period **(Fox and Mc Sweeney, 1998).**

In general, and according to these authors, all the components varied more during the first and last two months of the lactation phase than in the middle **(Osman, 2017).**

II.3. Age of cows

The cows' age has a small but noticeable impact on the content of their milk (**Teshome, 2018).** As the cows progress in age, the milk lipid percent tends to decrease (**Ueda, 1999).**

II.4. Breed and genetic factors

Another factor that has a significant impact on milk content is the genetic background of the productive cow **(Pond, 1977).** There are obvious variations in milk content and yield across dairy cow breeds **(Teshome, 2018).** This is related both to variations in synthetic capacity between breeds, as well as to variations in milk protein allele frequencies, specific between different breeds **(Griffiths, 2010).**

The majority of studies on genetic variables influencing milk composition focused on protein content **(Lien *et al*., 1999; Jensen *et al*., 2012)** and milk fat **(Arnould and Soyeurt, 2009).** Milk from Jersey cows has the highest casein and true protein levels, while milk from Holstein cows has the lowest **(Depeters and Ferguson, 1992).**

In addition, the milk of cows of the Jersey breed contains more calcium, phosphorus and calcium than the milk of other breeds, including that of the Holstein breed; however, it has the lowest levels of sodium and chloride **(Depeters and Ferguson, 1992).**

The content of milk from different breeds is given in **Table 02**.

Table 02. The typical content of different breeds' milk **(Goff and Hill, 1993).**

Breed	Protein	Fat	Total solids
Jersey	**3.98**	**5.13**	**14.42**
Holstein	**3.29**	**3.54**	**12.16**
Guemsey	**3.75**	**4.72**	**14.04**
Brown Swiss	**3.64**	**3.99**	**13.08**
Ayrshire	**3.48**	**3.95**	**12.77**

II.5. Feeding regime

As many milk components are obtained from precursors taken from the feed of the animals, perhaps it is not surprising that the manipulation of a dairy cow's diet can modify the composition of the milk (**Griffiths, 2010; Grummer, 1991; Castillo *et al.*, 2003).** Higher energy and lower roughage feeds, in general, will encourage increased fat content with a slight increase in protein level to supply a higher protein to lipid ratio **(Schroeder, 2012).**

Moreover, dietary fat may influence the content of protein, urea, citrate, and soluble calcium **(Banks *et al.*, 1984).** However, milk composition and protein content are less impacted by diet than milk fat. The variations might be due to changes in rumen activity **(Banks *et al.*, 1984).**

II.6. Dairy cow health

The health of a dairy animal can have an impact on its total performance, including reproductive efficiency, the quantity and quality of produced milk and its product **(Radostits *et al.*, 1994).** Disease can elevate the typical body temperature of lactating cows; this can have an impact on her milk content and yield **(Jai, 2014).**

Mastitis is one of the most dramatic causes influencing the quality and composition of milk **(Griffiths, 2010).** Cows with mastitis and other infections can produce a variety of metabolites in their milk **(Hettinga *et al.*, 2009).**

According to **Laben (1963),** mastitis may decrease milk yield, protein, and SNF by up to 10% to 12%. During mastitis, milk's pH rises to approach the pH of blood **(Fox and Mc sweeney, 1998).**

In addition, mastitis does not modify the overall protein content considerably, although it has been observed that casein levels increase while the level of immunoglobulin and albumin rise also **(Dohoo and Meek, 1982).** Even subclinical mastitis has been shown to raise somatic cell count, chloride, sodium, free fatty acids, and blood component levels in milk while lowering solids-not-fat, fat, and lactose levels **(Jai, 2014).**

II.7. Individual cow differences

Individual cow milk differs depending on the parameters listed above, as well as additional aspects like the cow's heredity and wellbeing (**Ueda, 1999).**

II.8. Milking completeness

The first milk extracted from the udder has a low fat content, whereas the final milk drawn has a high fat content **(Jai, 2014).** This is explained by the fact that fat droplets tend to accumulate in the upper parts of the alveoli due to their low density **(Jai, 2014).**

II.9. Interval between milkings

Protein and SNF levels do not vary significantly with milking interval **(Walstra *et al.*, 2006).** The amount of fat in milk differs between morning and evening milk, because of the shorter period between morning and evening milking than between evening and morning milking **(Jai, 2014).**

II.10. The farm's hygienic status

Dirty cows, filthy parlors, unhygienic milkers'hands**,** and contaminated equipment, all contribute to an increased bacterial count in the bulk tank **(Bruktawit, 2016).**

II.11. Adulteration practices

Dairy middlemen try to compensate for the dilution by adding vegetable oil, water, flour, starch, sugarcane, whey powder, and other substances to increase the solid content **(Teshome, 2018).**

Chapter II:

PROCESSED MILK

I. Thermal treatment of milk

In the dairy sector, thermal treatment is considered as the main process of this industry (**Lewis, 2010).** It is defined as the combination of the temperature and the time necessary to inactivate undesirable enzymes and microorganisms, while causing an acceptable degree of chemical modifications in foods **(Ryley and Kaida, 1994; Toledo, 2007).**

I.1. Types of heat treatments

Several thermal treatments for milk processing are used depending on the application **(De Jong, 1996):**

- **Thermisation:** It is used for the inactivation of psychrotrophic microorganisms (**Griffiths, 2010).**
- **Low pasteurisation (LTST):** It is utilized for the inactivation of both pathogenic and psychrotrophic micro-organisms (**Hotrum *et al.*, 2010).**
- **High pasteurisation (HTST):** It is employed in order to inactivate all micro-organisms, except for spores (**Griffiths, 2010).**
- **Sterilization or Ultra-High Temperature treatment (UHT):** It is used to inactivate all micro-organisms and spores (**Hotrum *et al.*, 2010).**

Pasteurization and ultra-high-temperature (UHT) treatments are the most common heat processing for milk products (**Dos Reis Coimbra, 2016).**

I.1.1. Pasteurized milk

The International Dairy Federation **(IDF, 1986)** defined pasteurisation as a process used to eliminate public health dangers caused by pathogenic microorganisms associated with milk, by the use of heat treatment that is consistent with a minimum of organoleptic, physical, and chemical modifications to the product. Furthermore, **EU (European Union)** regulations demand that the freshly pasteurized milk must be considered to pass a coliform test, having a plate count of fewer than 50 000 mL-1 post incubation at 6◦C for five days (**Hillerton *et al.*, 2004).**

Pasteurization achieves a 5 decimal decrease in C. burnetii, so the deactivation of Salmonella and Campylobacter, both of which cause food poisoning outbreaks in milk, will be greater. Listeria spp are also deactivated **(Codex Alimentarius, 2003).**

Moreover, pasteurization for 30 minutes at 56 or 62.5°C effectively removed both HIV-I-infected cells preparations and added cells-free HIV-I by at least five and six magnitudes, respectively **(Orloff *et al., 1993*).**

Bovine milk is pasteurized in a holder for 30 minutes at 62.5 °C or with HTST treatment for 15 seconds at 70 °C **(Garza *et al.*, 1986**). Pasteurized milk should be stored under refrigeration having a relatively limited shelf life **(Meunier-Goddik and Sandra, 2002).** In addition, the shelf-life of these products stored under refrigeration (4 ^{o}C) ranges from 7 to 14 days **(Early, 1998).** However, pasteurized milk made from high-quality raw milk can be kept for up to 18 days at 8°C as well as between 25 and 40 days at 4 °C **(Ravanis and Lewis, 1995; Gomez Barroso, 1997).**

I.1.1.1. Methods of pasteurization

Depending on the time and the temperature used, pasteurisation is classified as low-temperature long-time or high-temperature short-time **(Teshome, 2018).** These heating conditions (time and temperature) depend upon the microbiological quality of raw milk, sugar amount, or fat of milk also differs from one country to another, depending on the heat resistance of the microorganism strain **(Teshome, 2018).**

I.1.1.1.1. High-temperature short time (HTST)

Pasteurization is currently generally done in a continuous process known as the high temperature, short time (HTST), (**Lewis, 2010).** The typical HTST is 71.7°C for 15 seconds **(Bell, 2006).** Modern HTST machines can have capacity of up to 50,000 l /h (litres per hour), and these machines function at high regenerative efficiency (>95%) are capable of running for up to 20 hours before needing to be cleaned (**Lewis, 2010).**

I.1.1.1.2. Low-temperature long-time (LTLT)

Pasteurization, also known as holder pasteurization, is a method of heating milk in a water bath at 62.5 °C for 30 minutes or at 68 °C for 10 minutes **(Updegrove, 2005; Daniel, 2018).**

The best storing quality of pasteurized milk is attained by employing temperatures less than 77°C that do not stimulate the development of spores and do not deactivate the LPO (lactoperoxidase enzyme) **(Driehuis, 2013).**

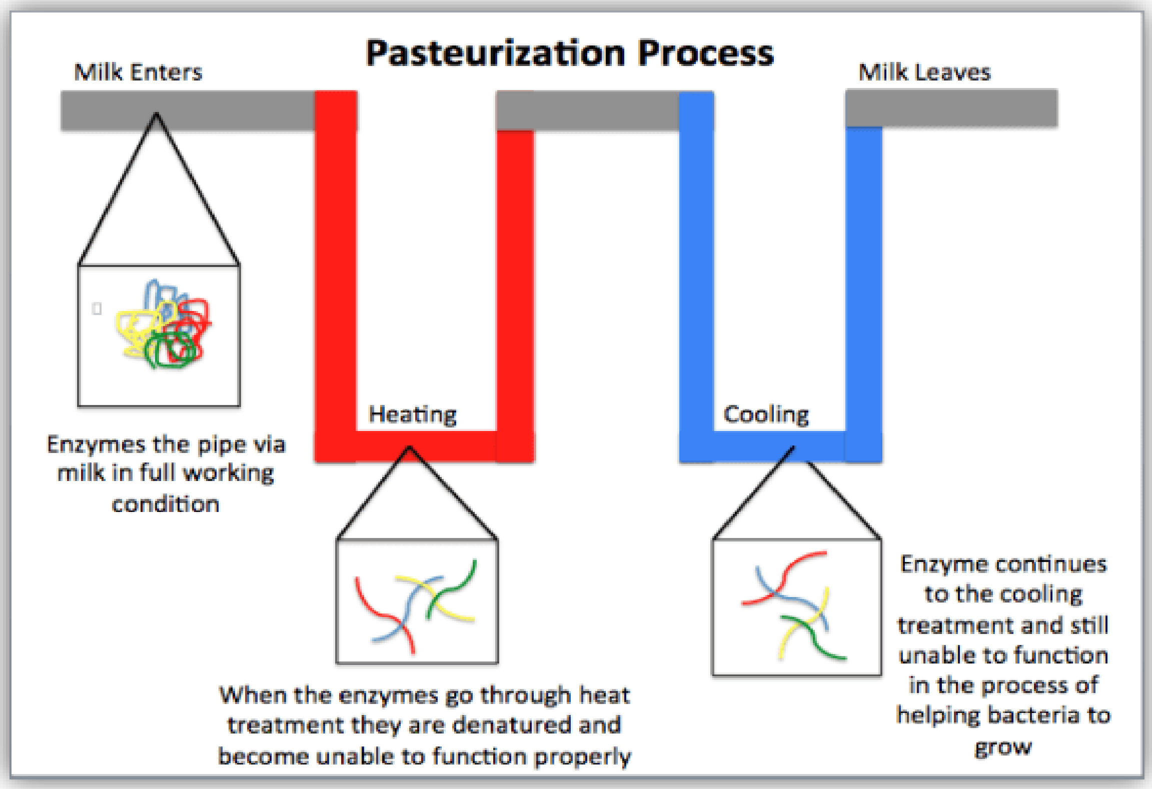


Figure 01. The HTST pasteurization process in steps **(Madhu, 2021).**

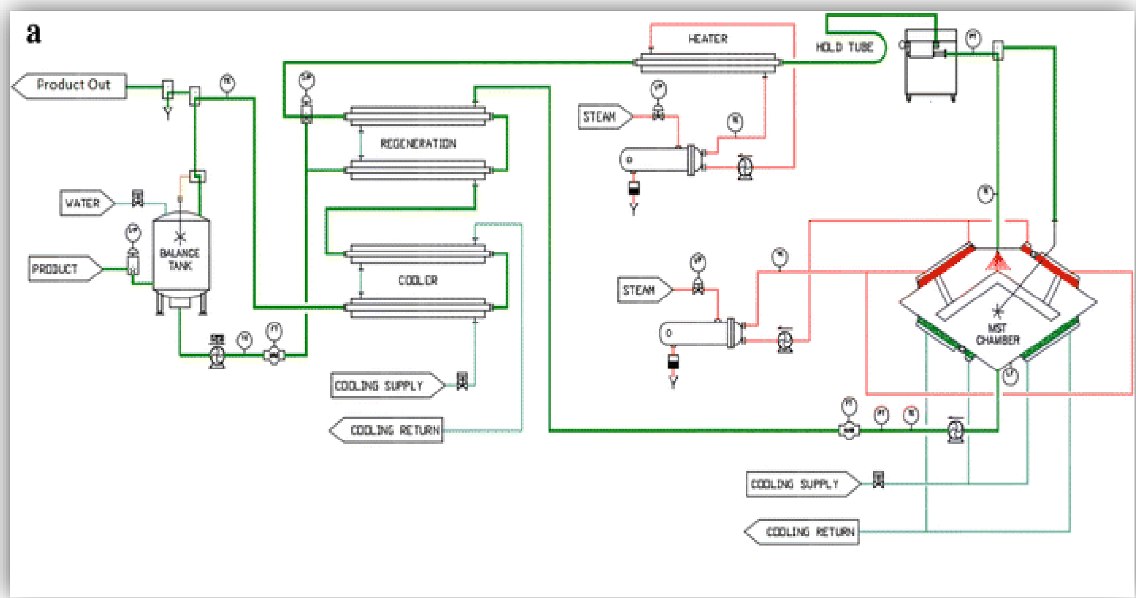


Figure 02. Schematic of the LTST process **(Myer *et al.*, 2016).**

I.1.2. UHT milk

Sterilisation is a heat treatment used in the fabrication of long-life products **(Malmgren, 2007).** Ultra-high-temperature (UHT) milk is a milk that has been heated to over 130 ºC for 1 second or more **(Bell, 2006).**

All microorganisms that can develop in normal storage conditions are destroyed during UHT milk processing **(Lewis and Deeth, 2009; Deeth, 2010).** This process generally extends the milk's shelf life by up to six months without refrigeration **(Raynal-Ljutovac *et al.*, 2007).**

All UHT operation entail the product's aseptic packing into plastic bottles laminated plastic cartons, or cartons **(Robertson, 2006).**

I.1.2.1. UHT processing methods

There are two principal technologies distinguished by the use of the medium for heating to an ultra-high temperature (**Malmgren, 2007).** UHT heating can be "direct" or "indirect" **(Tamine, 2009).**

A significant operational difference between direct and indirect plants is the capacity to recover heat utilized in the heating of milk **(Deeth, 2010)**. During direct heating, milk is mixed with superheated steam, while during indirect heating, a heat exchanger transmits heat across a divider between the heating medium and the milk, either hot water or steam **(Mehta, 1980; Burton, 1988).**

I.1.2.1.1. Direct heating

Commercial UHT sterilization is attained most successfully with direct heating systems like steam infusion or steam injection, in which the milk temperature is quickly increased to 140°C by direct steam mixing, followed immediately by fast cooling through water's flash vacuum evaporation that condenses the product from the vapor **(Goff and Griffiths, 2006).**

The main advantage of the direct heating method is highly quick heating, which reduces the pace of chemical changes **(Malmgren, 2007).** However, recovering the energy consumed in direct heating is extremely difficult, and the process is becoming very expensive **(Malmgren, 2007).**

I.1.2.1.2. Indirect heating

In the indirect approach, a barrier exists between the heating medium and the milk and the heating medium **(Bjerg, 2005).** Primarily based on tubular or plate heat exchangers and used at temperatures below the 80 ºC (**Malmgren, 2007).**

Whether it is the indirect or direct method, the milk is aseptically packaged following a cooling phase to assure a sterile product **(Lewis and Deeth, 2009).**

II. Heating -induced alterations in milk

A variety of chemical and physical changes occur when milk is heated **(Bjerg, 2005).** The extent of the chemical and physical modifications is determined by factors such as the heat treatment temperature, pH, and milk ionic composition **(Singh, 1993).**

II.1. Physical changes

II.1.1. Formation of sediment

Most heat-treated milk contains a certain quantity of sediment, which is usually undetectable by consumers **(Burton, 1988).**

II.1.2. Fouling

As the bacteria's fatal temperature is achieved, many milk proteins denature and tend to clump and deposit or precipitate on the hot surfaces, causing "fouling" **(Hagsten, 2016).**

II.2. Chemical changes

II.2.1. Fat

The size of fat globules is not affected by only heat treatment **(Malmgren, 2007).** As a result, it cannot have any negative nutritional effects **(Burton, 1991).**The impact is stronger at higher temperatures and pH levels **(Creamer and Matheson, 1980).**

II.2.2. Lactose

Various reactions incorporate milk sugar during UHT treatment, such as Maillard reactions and lactose isomerisation **(Malmgren, 2007).**

II.2.2.1. Lactose isomerization

During heat treatment, lactose (glucose + galactose) is converted to lactulose (fructose + galactose), which is positively linked with heat treatment **(Griffiths, 2010).**

Lactulose does not occur naturally, it is created when dairy products are sterilized **(Malmgren, 2007).**

Moreover, the quantity of lactulose in freshly formed UHT milk is highly associated with the amount of furosine, which is a measure of lactosylation, another heat-induced lactose interaction, and the degree of cooking flavor **(Cattaneo *et al.*, 2008).**

II.2.2.2. Maillard reactions

The Maillard reaction is a complicated set of reactions **(Hodge, 1953; Adrian, 1974)** in which the carbonyl group of lactose and the E "amino group" of lysine undergo a condensation process in milk **(Burton, 1988**). Further, due to the Maillard reaction, heat treatment of lactose causes browning and, at high temperatures, produces the slightly cooked or sweet taste of UHT milk **(Hagsten, 2016).**

II.2.3. Minerals

The balance between the colloidal and soluble calcium is affected and changed by several factors, such as heat treatment **(Fox and Mc Sweeney, 1998).** When a pure mineral solution is heated, calcium phosphate forms a thin layer on the surface that is less than 1µm thick, and there after, clusters are placed above this layer **(Hagsten, 2016).**

Furthermore, the ionic calcium concentration in milk is reduced by 10%–20% by using a higher-temperature heat treatment, such as in the UHT treatment **(Huppertz and Kelly, 2009).**

II.2.4. Proteins

The most discussed modification in the proteins of milk caused by thermal treatment is the whey protein denaturation (**Grewal, 2018).** This denaturation occurs at temperatures of over 65–70 °C, and these alterations are irreversible **(Dalgleish, 1993; Singh, 1993).** While soluble casein is produced when casein is heated in the absence of serum proteins, the quantity rises with temperature in the 90-150°C range and heating time (**Burton, 1988).**

The primary complex generated after milk heat treatment is the complex formed by micellar or serum κ –casein and β -Lg, where β-Lg connects to -casein through disulphide linkages **(Dalgleish, 1993).**

Kessler (2002) states that UHT processing inactivates almost all enzymes, since most of these enzymes found in milk are inactivated at temperatures lower than 100 °C, while certain lipases and proteinases require temperatures above 150 °C to be inactivated.

Upon heat treatment, le lactose, a reducing carbohydrate, combines with proteins in the Maillard reaction, resulting in the generation of acids, primarily formic acid **(Singh, 1993).**

II.2.5. pH

Pasteurisation improve the pH of fresh milk from 6.69-6.76 to 6.70-6.78; however, following in container sterilization, the pH of milk is significantly lowered (0.2-0.3 units) **(Grewal, 2018; Deeth and Lewis, 2017).** This was linked to intermediates of the Maillard reaction, formation of acetic acid, formic acid and proteolysis **(Van Boekel, 1998; Gaucher *et al.*, 2008).**

EXPERIMENTAL PART

1st part:

INFLUENCE OF SEASON AND LACTATION STAGE ON PHYSICOCHEMICAL PROPERTIES OF DAIRY CROSSBRED COW MILK.

Our research work is articulated around two parts

1) The first concerned the effect of the stage of lactation and season on the physico-chemical characteristics of crossbred cow milk.

2) The second focused on the study of physicochemical quality of three different types of whole milk (raw, pasteurized, and UHT).

1st part

INFLUENCE OF SEASON AND LACTATION STAGE ON PHYSICOCHEMICAL PROPERTIES OF DAIRY CROSSBRED COW MILK

I. Material and Methods

I.1. Study area and period

The study was conducted over four seasons; from December 2020 to November 2021, in three farmsin the region of Tiaret (Ain Guesma pilot farm, the experimental farm ofIbn Khaldoun University of Tiaret and the farm of Zoubeidi). The area is located in the western high lands of our country between 10° 26' of East longitude and 350° 15' of North latitude. It is a semi-arid regioncharacterizedby cold winter and hotdry summer.

I.2. Animals

The data collection from breeders was carried out following well-structured questionnaires, focusing on the breed, age, number and stage of lactations, parity, and feeding. The study involved fifty imported cross-breed cows clinically healthy, having the same age, number of lactations and number of parity. The animals were fed with the available fodder during each season, as well as a concentrate mixture. The stages of lactation considered are early (1–90 days), mid (91–180 days), and late (181 days and up) (**see appendix I**).

I.3. Sampling

557 raw milk samples were collected. The cows were milked mechanically twice a day (morning and evening). The milk samples were collected in sterile bottles, labeled and then placed in a cooler to be immediately transported to the laboratory of reproduction of farm animalsin the Veterinary Institute at the University of Tiaret for analysis.

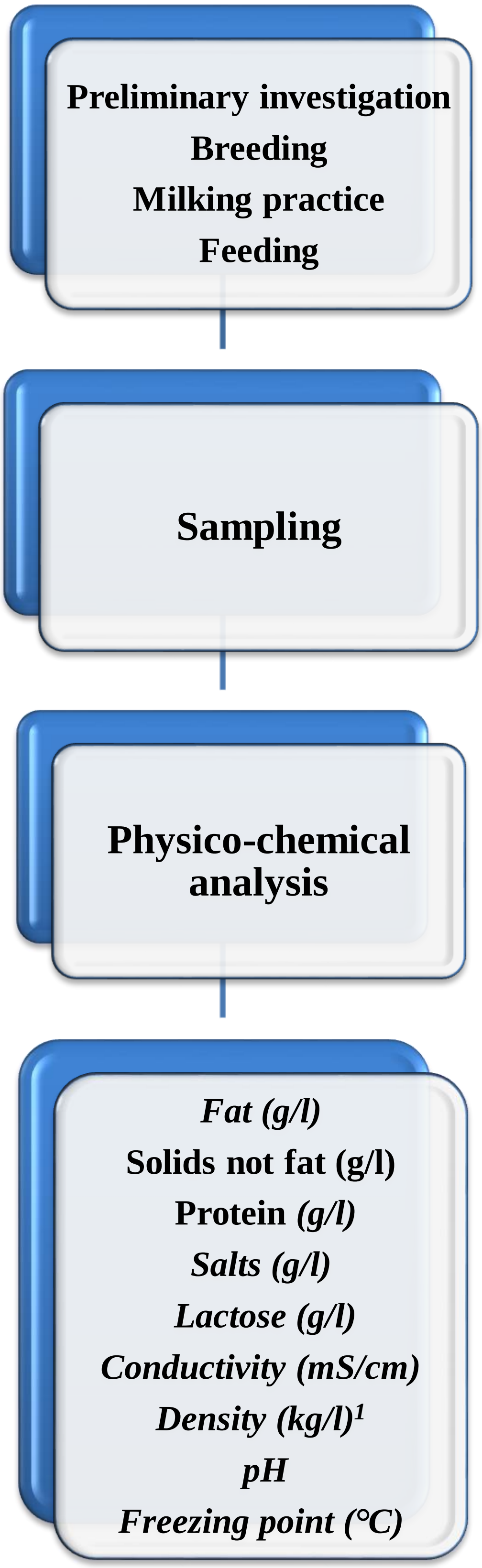


Figure 03. Experimental protocol followed for the evaluation of the Physico-chemical quality of raw cow milk.

I.4. Physico-chemical analysis

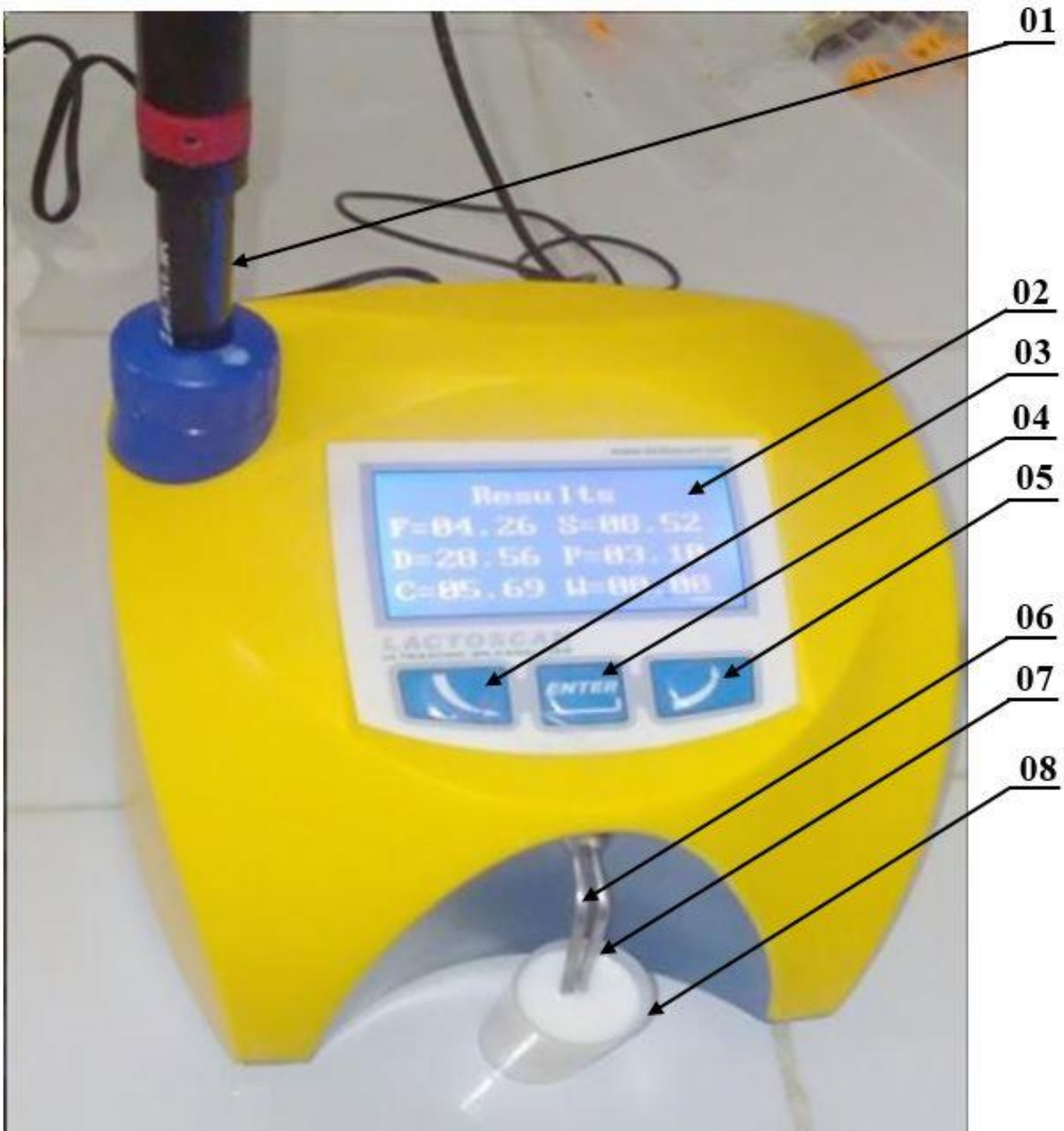
All the specimens were analyzed by an ultrasonic milk analyzer (Lactoscan SP). The physico-chemical analyzed parameters include fat (g/l), solids not fat (g/l), protein (g/l), salts (g/l), lactose (g/l), conductivity (mS/cm), density (kg/l), pH, and freezing point (°C).

The Lactoscan is a device that allows us to measure several parameters of milk quality. It has various advantages :

- ✓ Results are shown in less than 60 sec.
- ✓ There is no requirement for sample homogenization, preparation, or heating.
- ✓ It enables us to perform a high number of measurements.
- ✓ Needs small amounts of milk.
- ✓ The user can adjust the measurement.

Table 03. Measuring range of Lactoscan **(Milkotronic Ltd, 2019).**

Physico chemical parameters	Measuring range
Fat	0.01% to 45%
SNF	3% to 40%
Density	1000 to 1160 kg/m^3
Proteins	2% to 15 %
Lactose	0.01 % to 20 %
Water content	0 % to 70 %
Temperature of milk	1 °C to 40°C
Freezing point	– 0,4 to – 0,7°C
Salts	0,4 to 4%
pH	0 to 14
Conductivity	2 to 14 [mS/cm]
Total Solids	0 to 50 %



01. pH probe (option).	05. Button “Up”
02. Wide Display	06. Output pipe
03. Button “Down”	07. Input pipe
04. Button “Enter”	08. Sample holder

Figure 04. Ultrasonic milk analyzer (**Lactoscan SP**).

I.5. Statistical Analysis

The statistical analysis was performed using SPSS IMB 24. The collected data were subject to a simple descriptive statistical analysis (maximal and minimal values, mean, and standard error). In order to test the impact of the season and lactation stage, an analysis of variance (ANOVA) was performed.

II. RESULTS AND DISCUSSION

II.1. Seasonal effects on physicochemical features

Table **04** illustrates seasonal fluctuations in milk content.

Table 04. Seasonal effects on milk compositional properties.

Parameters	Season																Significance
	Winter				Spring				Summer				Autumn				
Fat (g /l)	a	18.2	±	0.09	a	18.6	±	0.09	a	17	±	0.08	b	25.7	±	0.09	**
Density (kg/l)	a	1.0344	±	0.28	a	1.0340	±	0.28	a	1.0346	±	0.29	b	1.0305	±	0.31	**
Conductivity (µS cm^{-1})	ab	5.14	±	0.04	b	5	±	0.04	a	5.29	±	0.04	c	4.55	±	0.07	**
Solid not fat (g /l)	a	96 .4	±	0.04	a	96	±	0.05	a	94.5	±	0.06	b	86.5	±	0.07	**
Protein (g /l)	a	35.3	±	0.01	a	35.1	±	0.02	a	34.7	±	0.02	b	31.6	±	0.02	**
pH	a	6.66	±	0.03	b	6.83	±	0.02	a	6.63	±	0.02	ab	6.75	±	0.02	**
Salts (g /l)	a	7.8	±	0.00	a	7.7	±	0.007	a	7.6	±	0.005	b	7	±	0.006	**
Freezing Point (°C)	a	-0.612	±	0.003	a	-0.608	±	0.004	a	-0.595	±	0.004	b	-0.545	±	0.006	**
Lactose (g /l)	a	53	±	0.02	a	52.8	±	0.03	a	52.1	±	0.03	b	47.9	±	0.04	**

NS**:** Not Significant**;*:** Significant (p≤ 0. 05);****:** High Significant (p≤ 0.01).

II.1.1. Fat

The season had a highly significant effect ($p \leq 0.01$) on cow milk fat content, with the greatest values (25.7±0.09g/l) during the fall season compared to other seasons. Further, there was a significant difference between autumn and the other seasons. However, no significant difference among winter, spring and summer was shown.

These findings were in line with those reported by **Sassi (2019)** in western Algeria, **Attia *et al.*, (2021), Chen *et al.*, (2014) and Cobanoglu *et al.*, (2017),** respectively in Tunisia, UK and Turkey**.**

On the other hand, **Smit *et al.*, (2000); Ozrenk *et al.*, (2008); Kabil *et al.*, (2015); Li *et al.*, (2019); Saadi *et al.*, (2019)** reported higher milk fat levels in winter. Furthermore, **Kawkab *et al.*, (2014); Matallah *et al.*, (2015)** found higher milk fat content during spring.

It is difficult to demonstrate the marked influence of the season on dairy cow performance, because of the combined effect of diet, photoperiod and physiological stage.

Milk fat is the most unstable component of the milk **(Hoden *et al.*, 1988)**. There are four main ways for the production of milk lipids, including direct feed ingestion, mobilisation from body fat reserves, rumen microbial production and mammary gland de novo synthesis **(Stoop *et al.*, 2009).**

According to **Ponce and Hernandez (2001)**, variations in the effects of seasonality on milk composition may be due to lower quality and less availability of feed given to animals throughout dry periods, which restrict energy supply to the mammary epithelial tissue and, consequently mammary secretory of milk elements. While in summer, cows remain outside for a very long time and consume grass **(Fox and MC Sweeney, 2004).**

Furthermore, the experiments conducted by **Dubeuf *et al.*, (1991)** reveal that grazing associated with significant modification in milk composition and production: on average, milk yield, protein, and fat levels risen respectively by 2.1 ± 2.5 kg/d, 0.8 ± 3.5 g/kg, and 1.4 ±1.9 g/kg among weeks (-3) and (+3) in comparison to grassing. This increase in milk fat content is attributed to an increase in long fatty acid production, which are abundant in fresh grass **(Essalhi, 2002).**

The cow's diet has a major impact on the milk's fatty acid composition **(Palmquist *et al.*, 1993)**. One of the most frequently proposed variation factors to determine milk fat content variations is the proportion of concentrate in the ration **(Journet and Chilliard, 1985; Sutton, 1989)**.

Basically, milk fat is primarily composed of volatile fatty acids, which themselves are generated from fermentable carbohydrates (starch) and parietal carbohydrates in feed (cellulose). Due to that, any dietary strategy that reduces B-hydroxybutyrate and acetate production within the rumen could result in a reduction of these substances in fat milk **(Yildirim and Cimen, 2009).**

In addition, grass utilised for grazing is typically less mature than grass cut for silage production, which also reduces the quantity of polyunsaturated fatty acids in the grass silage when compared to fresh grass, particularly C18:3 **(Ferlay *et al.*, 2006).** According to the conclusions of the **Garel and Coulon (1990) work**, grazing was associated with an increase in cheese production in both spring and autumn in comparison to winter feeding.

Our results showed a rise in fat percentage during the autumn season, which can be explained by the nature and composition of the food ration, having a large supply of energy after giving the cows corn silage.

Moreover, the season is expressed through the duration of light **(Matallah *et al.*, 2015).** Photoperiod in dairy cattle involves a variety of hormonal modifications, which might influence reproduction, feeding behavior, growth, DMI, and milk production **(Dahl *et al.*, 1991).** Cows treated with melatonin showed a decreased plasma concentration of prolactin, a reduction in lactose levels, a decline in MY of 23%, and an increase in the concentration of CN, protein, and fat in milk **(Auldist *et al.*, 2007).** Consequently, hot weather (summer and fall) reduced milk production while increasing milk protein and fat content **(Yoon *et al.*, 2004).**

Eventually, it is plausible that the decrease in fat and protein during the winter observed in this research was impacted by the photoperiod.

II.1.2. Density

Summer had the highest density (1.0346±0.29 kg/l) while autumn had the lowest one (1.0305± 0.31 kg/l).

Several authors **Mansour *et al.*, (2015) ; Sassi (2019); Parmar *et al.*, (2020)** also mentioned that the density was lowest during the fall season.While **Ciszter *et al.*, (2012)** reported highest one in autumn.

Milk density is influenced by the seasonal variations in milk composition observed throughout the year **(Parmar *et al.*, 2020)**. These modifications are essentially related to fat and solids not fat milk content, higher milk fat reflects reduced density **(Short, 1955).** As a result, the density of skimmed milk is more than 1035 **(Mansour, 2015).**

II.1.3. Conductivity

This parameter was determined to be highest in summer (5, 29±0,04µS cm^{-1}) and lowest in autumn (4.55±0.07µS cm^{-1}). Our findings are similar to those mentioned by **Křížová *et al.*, (2014)** on summer and winter milk.

Many factors, including the season, lactation stage, and feed, can affect conductivity **(Mabrook, *et al.*, 2003)**. With recent studies, electrical conductivity has primarily been expressed as the highest value for every quarter or milking; it is identified by the cations and anions concentration **(Norberg *et al*., 2004)**.

According to **Webb** and **Johnson (1965)**, milk's electrical conductivity has been regarded as a possible indicator of added water, mastitis infection, and neutralizers. If the cow has mastitis, the milk's concentration of Cl and Na+ rises, resulting in an increase in the EC of milk from the infected quarter **(Kitchen, 1981).** The pH reduction induces monohydrogen phosphate ion hydrogenation to dihydrogen phosphate, which has a lower molar conductivity **(Mucchetti *et al*., 1994).**

Acidification of milk, fermentation of lactose to lactic acid, and the soluble salt fraction are the main factors in the phenomenon that increases electrical conductivity **(Mucchetti *et al*., 1994).** Moreover, both milk protein and fat reduce the milk's conductivity **(Pinkerton and Peters, 1958)**. The cause of this conductance drop with rising fat content is that large globules account for more than 97% of total milk fat wrapped by a nonconductive thin membrane **(Muchetti *et al.*, 1994).**

II.1.4. Solid Not Fat (SNF)

Regarding SNF, the greatest levels were detected in winter and spring with respective values of 9, 64% and 9, 6%. This trend is consistent with the results reported by **Křížová *et al*., (2014); Sourabh *et al*., (2016); Zaman *et al*., (2016); Lohaj *et al*., (2020); Kekan *et al*., (2021).** On the contrary, **Ozrenk *et al*., (2008)** found higher levels in summer than in winter.

Many factors can influence milk composition, including heat stress, which decreases the SNF content of dairy cow milk **(Kadzere *et al*., 2002).** According to **Haque *et al*., (2017)**, milk SNF is considerably higher during the winter season compared to the hot seasons, which confirms the current findings, supporting the hypothesis that the climate is in favour of animalsFurther, the quantity and quality of feed also affect the milk's SNF content **(Harris and Bachman, 2002; Mushtaq, 2009).** The SNF modifications can be attributed mainly to changes in protein and occasionally to the milk's lactose content **(Kekan *et al*., 2021).**

II.1.5. Protein

The protein content varied similarly to that of the SNF. Our results corroborate those of **Smit *et al*., (2000); Ozrenk *et al*., (2008); Cziszter *et al*., (2012); Křížová *et al*., (2014); Bernabucci *et al*., (2015); Kabil *et al*., (2015)**.

Nevertheless, our findings are different of those of **Sassi (2019)** who found higher levels of west Algerian milk protein during the fall season, and those of other authors in other countries: (**Yoon *et al*., 2004; Sourabh, 2016; Zaman *et al*., 2016; Parmar *et al*., 2020; Attia *et al*., 2021).**

This change could be related to the fact that a high intake of concentrate acts as a protein level stabiliser **(Bousbia *et al.*, 2013; Mansour, 2015).**

Additionally, the decline in milk protein could be due to unsatisfactory intestinal protein absorption, which might be likened to a surplus of soluble nitrogen and to a very reduced rumen undegradable protein concentration in the food **(Colombari *et al*., 1999)**.

Moreover, changes in protein content may be closely linked to photoperiod. In thiscontext, an important light-to-dark ratio reduces milk protein and fat content, which in turn might possibly result from increased prolactin **(Bocquier 1985; Sevi *et al*., 2004).**

Other factors, such as genetics, could influence the amount of protein in cow's milk. Cows with the genetic variant C in the CSNISI*C (alphs-s1-casein gene) are capable of producing milk with a higher level of protein **(Cardak, 2005).**

II.1.6. pH

The pH of milk ranged from 6.63 to 6.83 during different seasons. Similarly, **Sassi (2019)** found higher pH levels during spring in west Algerian milk. In contrast to **Mansour (2015),** who observed greater levels in summer in east Algerian milk.

The pH of milk provides precise information about its freshness state **(Aggad *et al*., 2010).** It conditions and modulates the dairy flora balance **(Ramet, 1985).**

In addition, microbial infections can substantially affect the pH levels. Acute forms have a tendency to acidify the milk, whereas chronic forms tend to alkalinize milk (**Araba, 2006).**

II.1.7. Salts

In contrast to the fall season (0.70 ± 0.006 %), winter, spring, and summer seasons recorded the highest minerals percentage levels (0.78±0.00%, 0.77±0.007%, 0.76±0.005%) respectively. This finding is in good agreement with those mentioned by **Smit *et al.*, (2000) and Zaman *et al.*, (2016)**, in terms of signification.

Salts constitute a small portion of the milk composition in comparison to proteins or lipids, but they play a crucial role in the stability and structural integrity of casein micelles **(Nero and De Carvalho, 2018)**. Its changes depend on animal nutrition, genetic and environmental factors, and the stage of lactation **(Nero and De Carvalho, 2018).**

According to **Auldist *et al.*, (1995),** milk calcium content fluctuates throughout the year in a manner akin to milk casein content because a major fraction of milk's calcium is existent in the casein micelles, in colloidal calcium phosphate form.

II.1.8. Freezing point:

Freezing point showed the lowest levels in winter and the greatest levels in autumn**,** intermediate levels were recorded in spring and summer.

Sassi, (2019) stated that the season of the year had a significant effect on the freezing point in west Algeria, which supports our study. Similar observations were reportedby **Brzozowski and Zdziarski (2005); Zaman *et al.*, (2016)** in other countries.

In general, the season of the year has a significant impact on the milk's freezing point **(Zaman *et al.*, 2016)**. The Modifications in diet and temperature are thought to be mainly responsible for the seasonal impact on milk freezing point depression **(Henno *et al.*, 2008).**

Moreover, the milk that had the lowest freezing point was also characterised by the highest fat and protein concentrations and consequently had the greatest total solids **(Kędzierska-Matysek *et al.*, 2011).**

In fact, lactose is responsible for 53.8% of the freezing point depression in cows **(Brouwer, 1981).** Beside that, the freezing point dropped by 0.0007 C^0 as fibre content increased from 11% to 19% **(Kędzierska-Matysek *et al.*, 2011).**

However, other authors stated that the rise in milk freezing point was not due to a lack of protein or energy in the feed ration but was possibly caused by the increased water intake as a result of elevated temperatures and hours of sunshine **(Bjerg *et al.*, 2005).**

II.1.9. Lactose

Lactose levels were close in winter, spring, and summer, thendecreased significantly in autumn. A significant effect of the season on milk lactose content wasconfirmed by **Chládek *et al*., (2011); KdzierskaMatysek *et al*., (2011); Sourabh *et al*., (2016); Parmar *et al*., (2020)**. Whereasseveral authors mentioned different findings in other countries **(Křížová *et al*., 2014; Bernabucci *et al*., 2015; Zaman *et al*., 2016; Li *et al*., 2019; Sassi, 2019; Lohaj *et al*., 2020)**.

Lactose is the maincarbohydrate in milk (**Nero and De Carvalho, 2018),** whichdetermines milk volume **(Gurmessa and Melaku, 2012).** A strong relationship exists between lactose synthesis and the volume of water drawn into the milk, which makes lactose a stable componentof milk **(Pollott, 2004).**

The low lactose levels may be linked to mastitis as a result of an increase in somatic cell count during hot seasons, which increases the likelihood of udder infection. Similar arguments were mentioned by **(Rajčević *et al*., 2003; Malek dos Reis *et al*., 2013).**

In our study, the season had a highly significant ($p \leq 0.01$) effect on all physicochemical parameters of raw cow milk.

II.2. The effect of stage of lactation on physicochemical characteristics of raw milk

Table **05** shows the impact of lactation stage on milk content.

Table 05. Influence of the lactation stage on milk compositional quality.

Parameters	Lactation stage												Significance
	Ealy				Mid				Late				
Fat (g/l)	a	17.9	±	0.07	b	20.5	±	0.08	b	20.8	±	0.09	*
Density (kg/l)	a	1.0337	±	0.27	a	1.0313	±	0.29	a	1.0333	±	0.27	NS
Conductivity (µS cm⁻¹)	a	5.06	±	0.04	b	4.86	±	0.05	a	5.08	±	0.04	**
Solid not fat (g /l)	a	93.99	±	0.05	a	92.6	±	0.06	a	93.9	±	0.05	NS
Protein (g /l)	a	34.52	±	0.02	a	33.8	±	0.02	a	34.34	±	0.01	NS
pH	a	6.75	±	0.02	a	6.68	±	0.02	a	6.72	±	0.02	NS
Salts (g /l)	a	7.64	±	0.005	a	7.52	±	0.005	a	7.62	±	0.005	NS
Freezing Point (°C)	a	-0.596	±	0.004	a	-0.583	±	0.005	a	-0.594	±	0.003	NS
Lactose (g /l)	a	51.76	±	0.03	a	51.32	±	0.03	a	51.59	±	0.02	NS

NS**:** Not Significant**;*:** Significant ($p \leq 0.05$);****:** High Significant ($p \leq 0.01$).

II.2.1. Fat

From early (17, 9±0.07g/l) to late (20, 8±0.09g/l) lactation, the fat increased significantly (p≤0.05). These results are in line to those of **Benyounes *et al.*, (2013); Meribai *et al.*, (2015); Meklati *et al.*, (2017),** who showed that fat content increased during the later stages of lactation. Besides that, similar observations from other countries were noted **Yoon *et al.*, (2004); Stoop *et al.*, 2009; Akhand Pratap *et al.*, 2014; Legarto *et al.*, 2014; Jónás *et al.*, 2016; Shuiep *et al.*, 2016; Cobanoglu *et al.*, 2017; Gulati *et al.*, 2018; Sahib *et al.*, 2019).**

However, **Stanton *et al.*, (1992) and Bohmanova *et al.*, (2009)** revealed that milk's fat was lower, mainly in the late stage of lactation.

The composition and physicochemical properties of milk are directly dependent on the biosynthesis process, which happens during the lactation period of the animal **(Renhe, *et al.*, 2019).**

The lactation curve of dairy cows is well known. After the lactation peak and just before the dry period, milk yield begins to drop but body weight, protein and fat augment at the same time as a result of further apoptosis and the changes in the energy balance **(Fowler *et al.*, 1990; Pirlo *et al.*, 2000; Heins *et al.*, 2006).**

During early lactation, the cows would have been in a negative energy balance. Moreover, as the lactation period proceeds, progesterone and oestrogen levels rise while prolactin levels reduce (**Neville *et al.*, 2001)**. These hormonal changes cause mammary gland regression and the foetus's nutritional needs reducing nutrients that are available for milk production **(Bell *et al.*, 1995).**

II.2.2. Density

Our results showed that the density content of raw milk during different stages of lactation was (1.0337±0.27 kg/l), (1.0331±0.29 kg/l) and (1.0333±0.27 kg/l) respectively.

The same findings were reported by **Akhand Pratap *et al.*, (2014)** who indicated greater density in earlylactation, in contrary **Boudalia *et al.*, (2016)** and **Meklati *et al.*, (2017)** found different values.

Differences in the composition and eventually density could be linked to a variety of factors, including the type of feeding throughout the study period, the climatic conditions, housing conditions during the winter and autumn, the temperature, and the lactation stage **(Parmar *et al.*, 2020).**

II.2.3. Conductivity

The highest level of conductivity value (5.08 ± 0.04µS cm^{-1}) was observed in the late stage of lactation, with highly significant ($p \leq 0.01$) influence of the stage of lactation.

Similarly, the works of **Sheldrake *et al.*, (1983); Jadhav *et al.*, (2008)** revealed that duration of lactation had a significant impact on milk conductivity, which increases as lactation progresses.

In addition, milk conductivity differs greatly among breeds and between individuals within a breed, as well as stage of lactation, rate of milk fat, time between two milkings, and milk temperature **(Hamann and Zecconi, 1998).**

II.2.4. Solid Not Fat (SNF)

Higher SNF content was recordedin the early and late stages of lactation (93.9±0.05 g/l) with no significant effect ($p \geq 0.05$) of these stages. Our findings were in agreement with those of **Gurmessa and Melaku (2012); Akhand Pratap *et al.*, 2014; Sahib *et al.*, 2019)**, who found no effect of lactation stage on SNF content whereas the stage of lactation had a significant impact on SNF levels **Nantapo *et al.*, (2014); Shuiep *et al.*, 2016; Meklati *et al.*, 2017).**

The higher SNF levels in the early and late lactation may be explained by the greater levels of non-fat components in the same stages as minerals, lactose, and proteins constitute the most of milk SNF.

II.2.5. Protein

Compared to fat, the highest level of protein was found during early lactation (34.52±0.02 g/l), with no significant impact ($p \geq 0.05$) of the stage of lactation. Previously, **AkhandPratap *et al.*, (2014); Meklati *et al.*, (2017); Sahib *et al.*, (2019)** confirmed the absence of a significant impact of lactation stage on milk protein ratio.

In contrast to, **Benyounes *et al.*, (2013); Meribai *et al.*, (2015); Cobanoglu *et al.*, (2017)** who reported opposite results Throughout lactation, milk's protein content remained constant **(Sudhakar *et al.*, 2013)**. In the first 17 weeks of lactation, fat fluctuations are more evident than protein changes **(Bousbia *et al.*, 2013)**. Further, milk yield and milk protein concentration are negatively associated **(Ravikala *et al.*, 2014).**

Another hypothesis concerning the proteine modification which is related to the health statue of lactating cows. For instance, mastitis decreases protein levels as a consequence of an elevated rise in a proteolytic enzyme's activity.

II.2.6. pH

The lowest raw milk pH (6.68±0.02) was registered at mid-lactation without any noticeable fluctuation.

In terms of significance, our findings were in concordance with those obtained by **Meklati *et al.,* (2017)** in central Algeria. Whereas in the studies of **Meribai *et al.,* (2015); Osman (2017)**, the lactation stage had a significant effect on pH.

Acidity and pH depend on minerals, casein, ions, the overall microbial flora and its metabolic activity, milk handling, milking hygiene conditions **(Matallah *et al.,* 2017).**

II.2.7. Salts

The salts levels were very close during different periods of lactation (early 7.64±0.005 g/l; mid 7.52±0.005g/l; late 7.62±0.005 g/l) with no detectable modification. However, **Benyounes *et al.,* (2013); Osman (2017)** observed a significant impact of the lactation stage on salts content.

Variations in trace element levels in cow milk are influenced by factors such as lactation stage, diet, age, location, race, production rates, and analysis method **(El-Hamdani *et al.,* 2016)**. Furthermore, milk yield and the evolution of mineral matter are inversely related **(Guéguen *et al.,* 1961).**

II.2.8. Freezing point

According to our study, the freezing point was at its lowest during lactation's starting (0.596±0.004 C^0) without considerable modification. This variation was similar to that reported by **Osman (2017).**

The freezing point of milk is an essential determinant of milk quality (**Zagorska and Ciprovica, 2013)**. It is influenced by the stage of lactation, successive lactations, geographic region, and breed (**Kędzierska-Matysek *et al.,* 2011).**

Indeed, very low protein levels or increased cell counts can reduce milk's freezing point to -0.515 C^0 causing problems **(Cauty and Perreau, 2003).**

II.2.9. Lactose

Lactose amounts showed a similar trendto milk protein. **Sudhakar *et al.*, (2013)** and **Sahib *et al.*, (2019)** obtained the sameresults for the less affected lactation stages on this component. Nonetheless, several authors found a significant effect of lactation stage on milk lactose **Benyounes *et al.*, (2013); AkhandPratap *et al.*, 2014; Shuip *et al.*, 2016; Sourabh *et al.*, 2016; Osman, 2017).**

Lactose is the most stable constituent of milk when compared to other milk components **(Chen *et al.*, 2014)**. It does not change under various management circumstances because of its osmotic regulation effect **(Shuiep *et al.*, 2008; Ravikala *et al.*, 2014).**

The concentration of milk lactose rises slightly as production rises and decreases gradually at the lactation's end along with production **(Friggens *et al.*, 2007; Ravikala *et al.*, 2014).** In addition, lactose and water secretion rates are nearly constant all through lactation **(Pollott, 2004).**

According to **Dubey *et al.*, (1997),** milk lactose slowly increased as the lactation stage progressed, reaching a peak in the fourth month of lactation and slowly reducing.

2nd part

COMPARATIVE STUDY OF THE PHYSICOCHEMICAL QUALITY OF DIFFERENT TYPES OF WHOLE MILK (RAW, PASTEURIZED, AND UHT).

2nd part

COMPARATIVE STUDY OF THE PHYSICOCHEMICAL QUALITY OF DIFFERENT TYPES OF WHOLE MILK (RAW, PASTEURIZED, AND UHT).

I. Material and Methods

I.1. Sample collection

The experiment was performed over a period of 2 years, from March 2020 to February 2022. A total of 290 whole milk samples were tested, including 140 raw mixed milk, 90 UHT milk, and 60 pasteurized milk.

Different brands of UHT and pasteurized milk were bought randomly from supermarkets. These samples were collected at different production dates.While the raw milk samples were taken from the dairy of "SIDI KHALED". All samples were collected in the early morning and transported immediately to the laboratoryof reproduction of farm animals.

I.2. Physicochemical analysis

Each specimen was examined for the content of protein (P), SNF (solids not fat), fat (F), salts (S), lactose (L) and total solids (A). Simultaneously, the physical analysis includes tests of density (D), freezing point (FP), conductivity (C), and pH by Lactoscan sp.

I.3. Statistical analysis

SPSS software (version 24) was used to tabulate and analyze data from various physicochemical parameters of different milks. The coefficient of variation, mean, extreme values, and standard deviation were analyzed using descriptive statistics.

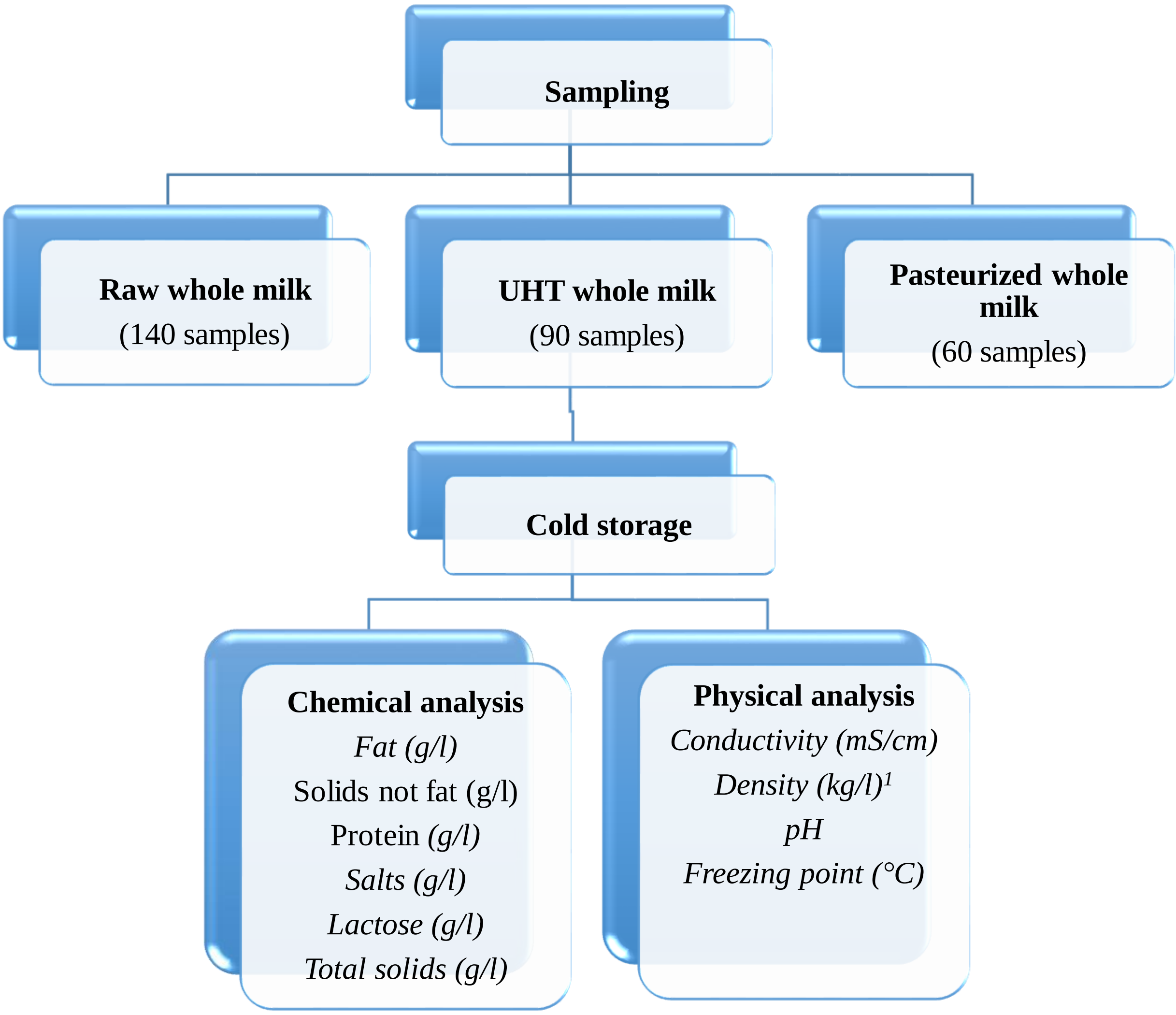


Figure 05. The experimental protocol used to analyse the physicochemical quality of raw and processed milk.

II. RESULTS AND DISCUSSION

The findings of the physical-chemical properties analysis of the three types of milk are presented in Tables **06** and **07**.

Table 06. Chemical composition of the samples.

Parameters	*type of milk*	*N*		*Mean*	±	*SE*	*MIN*	*MAX*	*CV*	*Significance*	*standard*	*References*
Fat (g/l)	RAW	140	a	34.2	±	0.04	22.5	51.6	15%	**	34 – 45 30 – 45	(Tamine, 2009) (JORA ,2004)
	UHT	90	b	28.7	±	0.01	17.9	31.9	6%			
	P	60	c	27.8	±	0.05	13.8	38.7	16%			
SNF (g/l)	RAW	140	a	86.8	±	0.03	75.1	96.2	4%	**	> 85 90-95	(Tamine, 2009) (JORA ,2004)
	UHT	90	b	81	±	0.06	70.6	92.9	8%			
	P	60	c	84.2	±	0.05	55.8	89.6	5%			
Protein (g/l)	RAW	140	a	32	±	0.02	27.2	51.8	7%	**	> 29	(Tamine, 2009)
	UHT	90	b	29.3	±	0.02	20	34	9%			
	P	60	c	31	±	0.01	29.9	34 .2	3%			
Minerals (g/l)	RAW	140	a	7	±	0.003	6.1	7.7	5%	**	7 – 7.5	(Leymarios, 2010)
	UHT	90	b	6.7	±	0.004	5.8	7.6	6%			
	P	60	c	6.9	±	0.002	6.7	7.3	2%			
Total Solid (g/l)	RAW	140	a	121.2	±	0.05	10.26	137.7	5%	**	12 5 - 130	(JORA ,2004)
	UHT	90	b	109.7	±	0.09	44.5	122.5	8%			
	P	60	c	112.5	±	0.04	98.2	119.2	3%			
Lactose (g/l)	RAW	140	a	477	±	0.01	42.8	51.9	4%	**	> 42	(Tamine, 2009)
	UHT	90	b	4,45	±	0.03	38.3	51.1	8%			
	P	60	c	4,66	±	0.01	44.9	49.6	0%			

NS: Not Significant;***:** Significant ($p \leq 0.05$);****:** High Significant ($p \leq 0.01$).

Table 07. Physical characteristics of the samples.

Parameters	*type of milk*	*N*		*Mean*	±	*SE*	*MIN*	*MAX*	*CV*	*Significance*	*standard*	*References*
Density (kg/l)1	RAW	140	a	1.030	±	0.002	1.020	1.240	2%	NS	1 .028 –1.032 1.028 – 1.036	(Leymarios, 2010) (Luquet, 1985)
	UHT	90	a	1.030	±	0.002	1.020	1.240	2%			
	P	60	a	1.029	±	0.00	1.030	1.030	0%			
Conductivity (µS cm-1)	RAW	140	a	5.31	±	0.04	4.15	5.86	9%	**	4 – 5.5 (at 25 °C)	(Leymarios, 2010)
	UHT	90	b	4.23	±	0.05	3.26	5.72	13%			
	P	60	c	4.35	±	0.05	3.79	4.96	9%			
Freezing point (°C)	RAW	140	a	-0.553	±	0.002	-0.61	-0.48	-5%	**	≤ -0.520	(Packard and Ginn, 1990)
	UHT	90	b	-0.514	±	0.005	-0.62	-0.44	-9%			
	P	60	c	-0.534	±	0.002	-0.57	-0.52	-2%			
pH	RAW	140	a	6.46	±	0.01	5.97	6.90	3%	**	6.6 – 6.8	(Leymarios, 2010) (JORA, 1998)
	UHT	90	b	6.72	±	0.009	6.29	6.90	1%			
	P	60	c	6.74	±	0.02	6.05	6.97	2%			

NS: Not Significant;***:** Significant (p≤ 0. 05);****:** High Significant (p≤ 0.01).

II.1. Nutritional composition

II.1.1. Fat

According to the outcomes in Table 1, we found a high fat mean value in raw milk (34.2±0.04 g/l). All types of processed milk were below Algeria's regulation standards. Concerningthe coefficient of variation, pasteurized milk was the most variable.

Regarding raw milk, close fat results (34.57±0.52 g/l) were obtained by **Kasmi *et al.*, (2021)**. **Boudalia *et al.*, (2016)** also mentioned that the rate of milk fats was between 30–40 g/l during the 3 months of expirementation in the east of Algeria. Other Algerian regions had higher levels were found by **Zitoun *et al.*, (2011)**; **Debouz *et al.*, (2014)**; **Bousbia *et al.*, (2018)**; **Hamiroun *et al.*, (2019)** Respectively in Constantine, Ghardaïa, Guelma and Djelfa.

Whereas lower values were found in Tissemsilt, Djelfa in Algeria respectively by **Tir *et al.*, (2015)**; **Lounis and Harfouche (2020)**, in Tunisia by **Sboui *et al.*, (2009)**; and in Morocco by **Srairi *et al.*, (2005)**; **Labioui *et al.*, (2009)**; **Bassbasi *et al.*, (2013)**; **El Hamdani *et al.*, (2016); Chrif *et al.*, 2019)**.

Concerning processed milk, our findings were higher than those reported by **Fernane *et al.*, (2016)** on samples of pasteurised milk in the same region. In addition, they were superior to those of **Fitouhi *et al.*, (2014)** in Tunisia in both UHT and pasteurised milk.

However, **Tadjine *et al.*, (2019)** reported higher levels than our results on pasteurised milk in the region of Guelma. Besides that, higher fat levels were mentioned in other countries by **Tallini, (2015)** and **Prodhan *et al.*, (2016)** for both pasteurised and UHT milk.

Lipids are the primary energy source in milk. It is present in the form of a fat cell emulsion; their composition comprises two major groups: triglycerides (simple lipids) and phospholipids (complex lipids) **(Guetouache *et al.*, 2014).**

In addition, milk fat percentage has a substantial economic impact on dairy producers, and even minor changes in fat levels can have a considerable impact on their economic returns **(Pennington, 2008).** Besides that, the finished product's texture and flavour are greatly influenced by the amount of fat used **(Guetouache *et al.*, 2014).**

Indeed, the most variable component of milk is thought to be lipids **(Lounis and Harfouche, 2020)**. It depends on the breed, lactation period, season, feeding and watering conditions, milking number, and milking time **(Mocanu *et al.*, 2011).**

Undoubtedly, feeding and milking time are the predominant factors in fat variation. The milk obtained during milking in the evening was more abundant in fat compared to that obtained in the morning **(Bouisfi *et al*., 2018).**

In our experiment, the fat levels were within the requirements. This is due to the fact that private farms are focused on the quantity and quality of their milk in order to be able to deliver it to the dairy of "Sidi Khaled" in Tiaret, which pays for the milk according to quality. Consequently, these farms do their best to improve the quality of their food, such as concentrate, forage, bran, corn, and pasture.

On the other hand, all types of processed milk were below the standards. It is possible that it was related to heat treatment or storage. The main factors influencing nutrients during storage are oxygen temperature and light (**Mehta, 1980).**

According to **El-Hadi *et al.*, (2015),** natural lipolysis results in the reduction of fat resulting from natural lipolysis based on heat-resistant lipases' activity naturally present in milk and whose activity may rise during the storage process of milk .Besides that,the composition and structure of fat globules are impacted by industrial processes **(Nero and De Carvalho, 2018)**. The number of fat globules increases and their diameter significantly decreases during the homogenization of milk (less than 1 micron) **(Guetouache *et al*., 2014).**

II.1.2. SNF

The greatest SNF level was found in raw milk (86.8±0.03 g/l). With an 84.2±0.05 g/l, pasteurized milk comes in second. Our findings revealed that both processed milk samples were outside the limits of Algerian standards.

For raw milk, our results were comparable to those revealed in the same area by **Kasmi *et al.*, 2021** (86.31 g/l) and **El Hamdani *et al.*, 2016** (86 g/l) in Morocco. However, these findings are lower than those obtained by **Aggad *et al.*, (2010)** in Tiaret; **Debouz *et al.*, (2014)** in Ghardaïa; **Hamiroune *et al.*, (2019)** in Djelfa and in several countries: **Bassbasi *et al.*, (2013)** and **Chrif *et al.*, (2019)** in Morocco; **Fredot, (2006)** in France. Otherwise, our findings were higher than those discovered in Guelma by **Boudalia *et al.*, (2016)** and **Bousbia *et al.*, (2018)**.

It is critical to note that milk SNF has attracted a lot of attention recently due to growing knowledge of the nutritional advantages of the non-fat element in milk **(Shuiep *et al*., 2016).**

II.1.3. Protein

In terms of protein, the average of the examined milk samples was (32±0.02 g/l), (31±0.01 g/l), and (29.3±0.02 g/l) for raw pasteurized and UHT milk, respectively. All samples tested in our experiment remained within the criteria.

Similarly, **Zitoun *et al.*, (2011)** reported an average of (32±0.1 g/l) in Algeria's east region for raw milk samples. These findings outperformed those of **Kaouche-Adjlane and Mati, (2017)** in The North-Central region of Algeria; **Tadjine *et al.*, (2019)** in Guelma; **Lounis and Harfouche (2020)** in Djelfa. Although, **Matallah *et al.*, (2017)** recorded higher protein levels in the El-Tarf region.

The protein content of pasteurized milk was comparable to that obtained by **Tadjine *et al.*, (2019)** but higher than that obtained by **Sebbane *et al.*, (2021)** in the region ofTizi-Ouzou. These values were lower than the most of previous reports **(Abd Elrahman *et al.*, 2009; Sissao *et al.*, 2015; Tallini, 2015; Prodhan *et al.*, 2016).**

The UHT milk levels were lower than the values mentioned in several works **(Lorenzen *et al.*, 2011; Tallini, 2015; Awal *et al.*, 2016; Prodhan *et al.*, 2016).**

Milk proteins have a high nutritional value, and the main component of milk proteins is casein, which accounts for approximately 75% of all milk proteins **(Webb *et al.*, 1974); Hassan, 2005).** The four major caseins in milk are αs1 caseins; αs2, B and k. Additionally, Milk protein content and protein characteristics are critical factors in cheese yield **(Vertès *et al.*, 1989; Remeuf *et al.*, 1989; Garel and Coulon 1990).**

It is worth noting that protein is much more stable than fat. Its levels are related to race, season, lactation, udder health, and a number of layouts **(Asif and Sumaira, 2010; Debouz *et al.*, 2014).**

Among these different factors, dietary variables come first. According to **Wolter (1997),** breeding that includes concentrate and corn silage raises protein levels, while breeding that depends entirely on grass or poor silage lowers them.

Other factors, such as heating and storage, can influence protein values. According to **Ammara *et al.*, (2009)** and **Awal *et al.*, (2016)**, storage time and heating have a significant impact on milk protein.

After heating, the majority of milk proteins coagulate **(Hamad *et al.*, 2017).** Indeed, the size of the casein aggregates is increased and their composition is altered by UHT processing **(Mehta, 1980).**

On the other hand, during storage, the texture changes **(Hamad *et al.*, 2017).** An inverse effect of storage on protein content has been reported in the literature by **(Alkanhal *et al.*, 1996; Yagoub, 2008; Looper, 2012).**

II.1.4. Minerals

The raw milk minerals ranged from 6.1 g/l to 7.7 g/l, with a mean of 7 g/l. While for UHT milk samples, it ranged from 5.8 g/l to 7.6 g/l, with an average of 6.7 g/l. Only raw milk values were in the norms.

The results obtained in the current study were higher than those observed by **Debouz *et al.*, (2014)** in "Ghardaïa" and **Bousbia *et al.*, (2018)** in "Guelma". However these values were lower than those mentioned by **Abd Elrahman *et al.*, (2009)** and **Sarfraz *et al.*, (2008).**

Milk salts are substances that exist as low molar mass ions in milk **(Renhe et *al*., 2019).** The major salt components are calcium, sodium, potassium, magnesium, etc (**Gaucheron, 2005**). Calcium levels would be influenced by caseins and citrate levels in milk **(Neville, 2005).**

Furthermore, variability in salt composition may be caused by the animal it self, whereas variability in distribution is more likely to be caused by process technology **(Renhe *et al*., 2019).**

According to **Lucey and Horne (2009),** heat causes irreversible modifications in salt distribution as well as casein micelles. Further, **Hansen and Melo (1977)** discovered that milk heated to 143 °C for 8 to 10 seconds had significantly less free calcium.

II.1.5. Total solids

The mean percentage of the milk solids for raw, pasteurized, and UHT milk was 121.2 g/l, 108.9 g/l, and 112.5 g/l, respectively. In addition, pasteurized milk had less variation than other milk. However, neither kind of milk satisfied the requirements.

Our findings were in close agreement with those mentioned by **Matallah *et al.*, (2017)** in the Algerian Northeast. Additionally, we obtained better results than **Tir *et al.*, (2015)** in Algeria, **Labioui *et al.*, (2009)** in Morocco, and **Sboui *et al.*, (2009)** in Tunisia.

In contrast, for UHT and pasteurised milk, our results were inferior to those reported by **Tallini *et al.*, (2015)** and **Fernane *et al.*, (2016**).

The seasonal availability of feed and fodder, as well as rumen nutrient digestibility, may have an indirect impact on total solids by changing the availability of milk component precursors **(Patbandha *et al.*, 2015)**. During the colder months, milk's water content decreases and its dry matter rises **(Gonzalo *et al.*, 2005).**

The rise in TS is directly related to the rise in protein and fat, both of which are diet-related **(Coulon *et al.*, 1991).** The changes in total solids in the current study were probably due to additional water, a problem in the quality of imported milk powder for UHT milk, or a fault in the manufacturing process.

II.1.6. Lactose

The results of lactose content showed that all types of milk were within acceptable limits. Furthermore, pasteurized milk had a coefficient of variation of 0%, reflecting a highly homogeneous distribution of results.

According to our results, the findings of **Abd Elrahman *et al.*, (2009)** and **Tallini, (2015)** were lower in processed milk. Besides this, the raw milk reports of **Labioui *et al.*, (2009); Sboui *et al.*, (2009); Matallah *et al.*, (2017)**; **Bousbia *et al.*, (2018)** were lower.

Whereas, our findings were inferior to those observed by **Sarfraz *et al.*, (2007); Debouz *et al.*, (2014); Lounis and Harfouche, (2020).**

Lactose, the main sugar in milk, is involved in the intestinal absorption of magnesium, phosphorus, and calcium as well as the utilisation of vitamin D **(El-Hamdani *et al.*, 2016)**; it also serves as a readily available energy source and a substrate for lactic acid bacteria **(Walstra *et al.*, 2006)**

Furthermore, Lactose is the most stable component of milk; its variation is greatly influenced by preservation conditions and milk microbiota **(Mocanu *et al.*, 2011).**

All of the chemical constituents of the three types of milk varied by a highly significant difference ($p \leq 0.01$).

II.2. Physical characteristics

II.2.1. Density

Regarding milk density, both UHT and raw milk had the same average (1.0306±0.002 kg/l). It was the only physical parameter with a lower fluctuation (CV: 0–2%) without a significant difference from the others. All samples conformed to the international standards.

These density values of raw milk correspond with those reported by many Algerian authors **(Matallah *et al.*, 2017; Chrif *et al.*, 2019; Tadjine *et al.*, 2019; Sebbane *et al.*, 2021)**, but were lower than those reported by **Hamiroune *et al.*, (2019).**

Furthermore, our values were higher than those mentioned by **Aggad *et al.*, (2010); Debouz *et al.*, (2014); Tir *et al.*, (2015); Bousbia *et al.*, (2018); Lounis and Harfouche, (2020); Kasmi *et al.*, (2021).**

Regarding processed milk, our results are in good agreement with those observed by **Fernane *et al.*, (2016)** in the same area. While higher than the findings of **Abd Elrahman *et al.*, (2009); Benyagoub *et al.*, (2014);** and **Bousbia *et al.*, (2021).**

The two main parameters used to determine the value of pure milk are density and fat **(Hnini *et al.*, 2018).** The use of a density feature is critical in calculating mass balance, which can assist in identifying various loss-making points in a process, estimating fat conversion process losses, and making critical process- and investment-related decisions **(Parmar *et al.*, 2020).**

This parameter varies depending on the milk's dry matter, fat, the animal's diet, and temperature **(Debouz *et al.*, 2014).** High-fat milk has a lower density compared to skim milk (**Mchiouer *et al.*, 2017).**

Moreover, the density is indirectly indicative of the milk's hygienic quality.Milk with a density of less than 1.0280 is deemed wetting milk **(Bonfoh *et al.*, 2002).**

Other factors influencing density include temperature and processing conditions such as homogenization and agitation **(Rutz *et al*., 1955; Sodini *et al*., 2004).**

II.2.2. Conductivity

According to our study, a low conductivity average value in UHT milk (4.23±0.05 µScm-1) was recorded. Compared to the density, the conductivity of the three kinds of milk was very highly different from each other.

The conductivity analysis revealed that it was higher than that of **Bousbia *et al.*, (2018)** in the east of Algeria, butlower than of **Kasmi *et al.*, (2022)** in the region of Tiaret. Furthermore, our findings are very different to those of **Prodhan *et al.*, (2016)** on UHT milk.

Electrical conductivity measurements are commonly used in food manufacturing to detect water contamination, metabolic activity and monitor microbial growth **(Carcia *et al.*, 1995; Curda and Plockova, 1995)**. It is principally due to the presence of diverse electrolytes **(Imran *et al.*, 2008).**

This conductivity rises with the temperature of the milk sample **(Wong, 1988).** When EC is measured at milking, it is expected to be slightly higher because the milk temperature is around 38°C when it emerges from the teat cistern **(Norberg *et al.*, 2004).**

The cow's udder health status has an impact on the electrical conductivity of the milk **(Norberg *et al.*, 2004).** Mastitis causes an increase in the concentration of Na+ and Cl in the milk, which leads to an increase in the EC of milk from the infected quarter **(Kitchen, 1981).**

Certain factors can also have an impact on the EC, such as temperature and storage period. According to **Capriţa *et al.*, (2014)**, the increase in electrical conductivity was positively impacted by the temperature and the duration of storage.

II.2.3. Freezing point

Only the UHT milk was outside the norms, with a maximal value of (-0.480°C) and a CV of (-9%). Additionally, all milk samples differ in a significant way.

The raw milk values reported in our analysis were greater than those revealed by **Debouz *et al.*, (2014)**. Despite this, it was inferior to those mentioned by **Bousbia *et al.*, (2018)** and **Hamiroune *et al.*, (2019).**

Both pasteurised and UHT milk values were lower than those reported in previous studies of **Abd Elrahman *et al.*, (2009); Prodhan *et al.*, (2016), Bousbia *et al.*, (2021).**

The main test for detecting fraudulent water addition to milk is the freezing point, which is directly proportional to the amount of dissolved molecules in the solution (**Fonseca-Santos, 2000).** A wetness of 1% raises the freezing point by about 0.0055 °C **(Goursaud, 1985).**

Water addition is not always intentional, and it can be the result of processing flaws such as residual water in heating equipment and the existence of micro-holes in heat exchangers in the cooling or heating sectors **(Beloti *et al.*, 2015).** Moreover, a high freezing point level denotes colostrum, mastitis-infected cow milk, or milk that has been diluted with water or salts of minerals **(Mocanu *et al.*, 2011).**

On the oter hand, stabilizers that are added to UHT milk function as solutes and may have a direct impact on the milk's density and freezing point **(Beloti *et al.*, 2015)**. In fact, the higher levels of UHT milk in our analysis could be probably due to the addition of stabilizing salts, so this parameter is not applied to assess the quality of UHT milk.

II.2.4. pH

Unlike the other physical parameters, the pH of raw milk samples did not meet the standards.

The findings are in agreement with the results of **Tadjine *et al.*, (2019)** (6.72 ±0.07) for pasteurized milk in the east of Algeria. Lower values were reported by **Abd Elrahman *et al.*, (2009); Fitouhi *et al.*, (2018); Bousbia *et al.*, (2021); Sebbane *et al.*, (2021)**.

Concerning raw milk, our results were lower than those of previous studies conducted in different regions in our country **(Aggad *et al.*, 2010; Zitoun *et al.*, 2011; Tir *et al.*, 2015; Kaouche-Adjlane and Mati, 2017; Matallah *et al.*, 2017; Tadjine *et al.*, 2019; Lounis and Harfouche, 2020).**

Milk acidity can be used as an indicator of milk quality at the time of delivery, allowing us to assess the amount of acid produced by bacteria or probable fraud **(Bourgeois *et al.*, 1996).**

The pH of milk is primarily determined by the presence of caseins as well as phosphoric and citric anions **(Vignola, 2002).** A portion of the micellar calcium phosphate diffuses into the soluble phase, increasing the $Ca2+$ ions concentration and disrupting the micelle structure, which significantly affects the milk acidity **(Muchetti *et al.*, 1994; Czerniewicz *et al.*, 2006).**

The variation in pH is related to food availability, climate, water intake, lactation stage milking conditions, and cow health **(Labioui *et al.*, 2009).** In addition, the pH levels of processed milk were possibly modify by heat treatment and storage periode.

According to **Tallini *et al.*, (2015)**, milk's pH increased as a result of pasteurisation and sterilisation, which can be explained by a reduction in the amount of whey protein linked to the micelles (**Tallini *et al.*, 2015**). Furthermore, pH levels decreased during storage.

Excepting the density, all of the physical parameters of the three kinds of milk varied by a highly significant difference ($p \leq 0.01$).

CONCLUSION

CONCLUSION

Concerning the effect of season on the variation in the physicochemical quality of raw crossbred cow milk in the Tiaret region, the results obtained showed that:

Important seasonal variations were revealed in concentrations of chemical milk compounds. The major constituents of cow's milk (solid not fat, protein, salts, and lactose) were highly significant in winter compared to other seasons. Except the fat content that was higher during the autumn season.

The season also had a very significant influence on the physical properties of samples; the highest density and conductivity were obtained in summer.

Indirect impact of the season on milk composition was linked to food availability and animal’s diet.

In terms of stage of lactation, the study showed that:

Fat levels tended to increase as the stage of lactation progressed, while other nutritional components were not affected.

All of the physical characteristics of the milk sample, with the exception of conductivity, were less influenced by the stage of lactation.

To sum up, we can confirm that the season has a big influence on variation in the physico-chemical quality of the milk than the stage of lactation in crossbred cows.

The results of the second part of the study showed that:

Raw milk was a highly nutritious food, while both types of processed milk were outside the recommended values, which can be attributed to the effect of heat treatment and poor storage conditions.

A lot of the physical parameters of the analyzed milk samples were within the required limits.

Dairy farmers are of special interest and deserve to be made more aware of milk quality, which is essential for the dairy industry and public health, through better management of dairy farming.

In light of the results of this investigation, the following recommendations are made:

It is important to identify other non-genetic factors that affect the milk composition throughout the year, in order to improve the raw milk quality since high-quality dairy products require high-quality raw milk.

It also necessary to be interested in the cattle breeding systems' development criteria, especially the availability of food and fodder.

Further studies on microbiological aspects and impact of packaging to ensure the nutritional and hygienic quality of milk would be of interest in the future.

Finally, it is essential to have Lactoscan in dairies as long as it is considered as an indispensable modern tool to control the quality of milk.

REFERENCES

REFERENCES

1. **Abd Elrahman, S. M., Ahmad, A. M., El Owni, A. O., & Ahmed, M. K. (2009).** Microbiological and physicochemical properties of raw milk used for processing pasteurized milk in Blue Nile dairy company (Sudan). *Australian Journal of Basic and Applied Sciences*, *3*(4), 3433-3437.

2. **Ackermann, P. W., Herrmann, T., Stehr, C., & Ball, M. (2006).** Status of the PCDD and PCDF contamination of commercial milk caused by milk cartons. *Chemosphere*, *63*(4), 670-675.

3. **Adjlane-Kaouche, S., Benhacine, R., Ghozlane, F., & Mati, A. (2014).** Nutritional and hygienic quality of raw milk in the mid-northern region of Algeria: Correlations and risk factors. *The Scientific World Journal*, *2014.*

4. **Adrian, J. (1974).** Nutritional and physiological consequences of the Maillard reaction. *World review of nutrition and dietetics*, *19*, 71-122.

5. **Aggad, H., Bridja, M., Aek, B., Benaouali, M., & Djebli, A. (2010).** Some quality aspects of pasteurized milk in Algeria. *World J. Dairy Food Sci*, *5*(1), 21-24.

6. **AkhandPratap, K. D., Kumar, P., & Singh, A. (2014).** Effect of pregnancy, lactation stage, parity and age on yield and components of raw milk in Holstein Friesian cows in organized dairy form in Allahabad. *J Agr Vet Sci*, *7*, 112-115.

7. **Al-Kanhal, M. A., & Arvas, E. (1996).** Electromagnetic scattering from a chiral cylinder of arbitrary cross section. *IEEE Transactions on Antennas and Propagation*, *44*(7), 1041-1048.

8. **Ammara, H., Imran, A., & Shahid, M. (2009).** Microbiological and physicochemical analysis of different UHT milks available in market. *African Journal of Food Science*, *3*(4), 100-106.

9. **Araba A (2006).** Conduite alimentaire de la vache laitière. Bulletin d'information et de liaison du PNTTA sur le transfert de technologie en agriculture, N° 136.

10. **Arnould, V. R., & Soyeurt, H. (2009).** Genetic variability of milk fatty acids. *Journal of Applied Genetics*, *50*(1), 29-39.

11. **Asif M, Sumaira U, (2010).** A Comparative study on the physicochemical parameters of milk samples collected from buffalo, cow, goat and sheep of Gujrat, Pakistan, Pakistan Journal of Nutrition 9(12), 1192-1197.

12. **Attia, K., Darej, C., M'Hamdi, N., Sadkaoui, G., & Moujahed, N. (2021).** Effects of rations and seasons on milk yield and composition in small and medium dairy farms from a Tunisian northern area (Bizerte Region). *Mljekarstvo: časopis za unaprjeđenje proizvodnje i prerade mlijeka*, *71*(3), 194-203.

13. Auldist, M. J., Coats, S., Rogers, G. L., & McDowell, G. H. (1995). Changes in the composition of milk from healthy and mastitic dairy cows during the lactation cycle. *Australian Journal of Experimental Agriculture*, *35*(4), 427-436.

14. Auldist, M. J., Turner, S. A., McMahon, C. D., & Prosser, C. G. (2007). Effects of melatonin on the yield and composition of milk from grazing dairy cows in New Zealand. *Journal of Dairy Research*, *74*(1), 52-57.Awal, M. S., Amin, M. R., Haque, M. R., Kamal, M. M., & Hasan, S. M. K. (2016). Evaluation of physico-chemical properties and detection of adulterants of UHT milk samples available in Bangladesh. *Int Res J Biol Sci*, *5*(2), 1-6.

15. Ayza, A., Yilma, Z., & Nurfeta, A. (2013). Characterization of milk production systems in and around Boditti, South Ethiopia. *Development*, *25*(10).

16. Banks, J.M., Muir, D.D. and Tamime, A.Y. (1984a). Comparison of cheese yield and cheese making efficiency using seasonal and standardized milk. *J. Soc. DairyTechnol.*37, 83-88.

17. Banks, J.M., Muir, D.D. and Tamime, A.Y. (1984b), Comparison of the quality of

18. Bassbasi, M., Hirri, A., & Oussama, A. (2013). Physico-chemical characterization of raw milk in the region of Tadla-Kelaa in Morocco by application of exploratory analysis. *International Journal of Innovation and Applied Studies*, *2*(4), 512-517.

19. Bell, C. R., Dickie, G. A., Harvey, W. L. G., & Chan, J. W. Y. F. (1995). Endophytic bacteria in grapevine. *Canadian journal of Microbiology*, *41*(1), 46-53.

20. Bell, J.A., Griinari, J.M., Kennelly, J.J., (2006). Effect of safflower oil, flaxseed oil, monensin, and vitamin E on concentration of conjugated linoleic acid in bovine milk fat. J. Dairy Sci. 89 (2), 733_748.

21. Beloti, V., Rios, E. A., Silva, M. R., Tamanini, R., Yamada, A. K., & da Silva, L. C. C. (2015). Determination of freezing point standard for UHT milk'. *Semina: Ciências Agrárias*, *36*(5), 3181-3187.

22. Bennett G, Liska BJ, Hempenius WL. (1965). Effect of other flavor components onthe perception of diacetyl in fermented dairy products. *J. Food Sci.* 30: 35-37.

23. Benyagoub, E., Ayat, M., & Belarbi, D. (2014). Physico-chemical quality assessment of ultra high temperature sterilized milk and milk products in Western Algeria. *South Asian Journal of Experimental Biology*, *4*(3), 85-90.

24. Benyounes, A., Bouriache, H. E., & Farida, L. (2013). Effet du stade de lactation sur la qualité physico-chimique du lait de vache Holstein élevée en région Est d'Algérie.

25. Bernabucci, U., Basiricò, L., Morera, P., Dipasquale, D., Vitali, A., Cappelli, F. P., & Calamari, L. U. I. G. I. (2015). Effect of summer season on milk protein fractions in Holstein cows. *Journal of dairy science*, *98*(3), 1815-1827.

26. Billon, P., Menard, J. L., and Berny Gaudin, V. (2001). La Detection des Mammites par la Mesure de Conductivite Electrique du lait. Bull. GTV 12, 35-39**.**

27. Bjerg, M., Rasmussen, M. D., & Nielsen, M. O. (2005). Changes in freezing point of blood and milk during dehydration and rehydration in lactating cows. *Journal of dairy science*, *88*(9), 3174-3185.

28. Bocquier, F. (1985). Influence of photoperiod and temperature on endocrinal balance and performances of the pregnant and lactating ewe.Thesis Docteur Ingenieur, Institut National Agronomique-Paris Grignon.

29. Bohmanova, J., Jamrozik, J., & Miglior, F. (2009). Effect of pregnancy on production traits of Canadian Holstein cows. *Journal of dairy science*, *92*(6), 2947-2959.

30. Boland, M., & Singh, H. (Eds.). (2019). *Milk proteins: from expression to food*. Academic Press, pp 03.

31. Bonfoh, B., Fané, A., Traoré, N. A., Coulibaly, Z., Simbé, C. F., Alfaroukh, O. I., ...&Zinsstag, J. (2002). Qualité microbiologique du lait et des produits laitiers vendus en saison chaude dans le district de Bamako au Mali. *Bioterre, Rev. Inter. Sc. de la Vie et de la Terre, Special*, (242-250).

32. Boudalia, S., Benati, D., Boukharoub, R., Chemakh, B., & Chemmam, M. (2016). Physico-chemical properties and hygienic quality of raw and reconstituted milk in the region of Guelma-Algeria. *International Journal of Agricultural Research*, *11*(2), 77-83.

33. Bouisfi, A., Bouisfi, F., & Chaoui, M. (2018). Variety of physicochemical characteristics of raw milk in elgharb region of Morocco : the relation between composition and climatic conditions. *International Journal for Quality Research*, *12*(4).

34. Bourgeois, C. M., Mescele, J. F., & Zucca, J. (1996). Food Microbiology (Tome 01); microbiological aspect of safety and quality of food. *Publishing technique and documentation Lavoisier Paris*, 272-292.

35. Bousbia A, Ghozlane F, Benidir M and Belkheir B (2013). Quantitative and qualitative response of dairy production of cattle herds to husbandry practices. African Journal of Agricultural Research 8(45), 6522-5629.

36. Bousbia, A., Boudalia, S., Gueroui, Y., Belaize, B., Meguelati, S., Amrouchi, M., ... & Benidir, M. (2018). Nutritional and hygienic quality of raw milk intended for consumption in the region of Guelma, Algeria. *Asian Journal of Dairy and Food Research*, *37*(3), 192-196.

37. Bousbia, A., Gueroui, Y., Boudalia, S., Benada, M., & Chemmam, M. (2021). Effect of high temperature, short time (HTST) pasteurization on milk quality intended for consumption. *Asian Journal of Dairy and Food Research*, *40*(2), 147-151.

38. Brooksbank, D. V. (1993). *Adsorption of milk proteins onto charged surfaces* (Doctoral dissertation, University of Glasgow).

39. Brouwer,T. (1981). Calculations concerning the determination of the freezing point depression of milk. Neth. Milk Dairy J., 35: 159–175.

40. Bruktawit, S., & Ashenafi, M. (2016). Physicochemical properties and microbial quality of cow milk collected from selected subcity of Addis Ababa, Ethiopia. *Addis Ababa University, College of veterinary medicine and Agriculture, Department of Animal Production Studies*.

41. Brzozowski P., Zdziarski K. (2005). Freezing point of udder-milk in milk-producing cows (in Polish). Med. Weter., 61: 934–936.

42. Bundelkhand University, Istitute of Food Technology. (2011). Draft East African Standard on Raw Milk 2010

43. Burton, H. (1988). *UHT Processing of Milk and Milk Products*, Elsevier Applied Science, London.

44. Burton, J. L. 1991. Effect of Recombinant Bovine Somatotropinon Immune Responses and Associated Parameters in Lactating DairyCows. Ph.D. Thesis, Department of Animal and Poultry Science, University of Guelph, Guelph, ON.

45. Caprit¸a, R. (2014). Evaluation of some physicochemical properties of milk caused by acidification. Scientific.papers Animal Science and Biotechnologies, 47(2): 137–141.

46. Carcia-Golding, F., M., Giallorenzo, N., Moreno and V., Chang, 1995. Sensor for determining the water content of oil-in-water emülsion by specific admittance measurement. Sensors and Actuators A. 46-47, 337-341.

47. Çardak, A. D. (2005). Effects of genetic variants in milk protein on yield and composition of milk from Holstein-Friesian and Simmentaler cows. *South African Journal of Animal Science, 35*(1), 41-47.

48. Castillo, M., Payne, F. A., Hicks, C. L., Laencina, J., & López, M. B. (2003). Effect of protein and temperature on cutting time prediction in goats' milk using an optical reflectance sensor. *Journal of Dairy Research*, *70*(2), 205-215.

49. Cattaneo, S., Masotti, F., & Pellegrino, L. (2008). Effects of overprocessing on heat damage of UHT milk. *European Food Research and Technology*, *226*(5), 1099-1106.

50. Cauty, I., & Perreau, J. M. (2003). La conduite du troupeau laitier. Editions France Agricole.

51. Chen, B., Lewis, M. J., & Grandison, A. S. (2014). Effect of seasonal variation on the composition and properties of raw milk destined for processing in the UK. *Food chemistry*, *158*, 216-223.

52. Chládek, G., Čejna, V., Falta, D., & Máchal, L. (2011). Effect of season and herd on rennet coagulation time and other parameters of milk technological quality in Holstein dairy cows. *Acta univ. Agric. Et silvic. Mendel. Brun*, *59*(5), 113-118.

53. Chotyakul, N. (2014). Extraction and quantification of vitamins from raw, HTST, UHT, and PATP milk and of diatom-produced chitin and glucosamine.

54. Chrif, M., Chouni, S., & Bouyahya, A. (2019). Changes of Physicochemical composition of Moroccan bovine's milk along the years. *Mediterranean Journal of Chemistry*, *8*(6), 470-475.

55. Claeys, W. L., Cardoen, S., Daube, G., De Block, J., Dewettinck, K., Dierick, K. ... & Herman, L. (2013). Raw or heated cow milk consumption: Review of risks and benefits. *Food control*, *31*(1), 251-262.

56. Claeys, W.L.; Verraes, C.; Cardoen, S.; De Block, J.; Huyghebaert, A.;Raes, K.; Dewettinck, K. and Herman, L. (2014). Consumption ofraw or heated milk from different species: An evaluation of the nutritional and potential health benefits. Food Control, 42:188-201.

57. Cobanoglu, O., Gurcan, E. K., Çankaya, S., Kul, E., Abaci, S. H., & Ulker, M. (2017). Effects of lactation month and season on test-day milk yield and milk components in Holstein cows.

58. Codex Alimentarius, Session, R., Du Comite, D. C., & Traites, S. (2003). Comisión del codex alimentarius. *Código de Prácticas para calidad alimentos. Roma : FAO/OMS*.

59. Colombari, G., Borreani, G., & Crovetto, G. M. (1999). Comparison of lucerne silage and ventilated hay in maize silage-based rations for dairy cows for the production of milk destined for Grana cheese.

60. Coulon, J. B., Chilliard, Y., & Rémond, B. (1991). Effets du stade physiologique et de la saison sur la composition chimique du lait de vache et ses caractéristiques technologiques (aptitude à la coagulation, lipolyse). *INRA Productions animales*, *4*(3), 219-228.

61. Creamer, L. K., & Matheson, A. R. (1980). Effect of heat treatment on the proteins of pasteurized skim milk. *New Zealand Journal of Dairy Science and Technology*.

62. Curda, L., & Plockova, M. (1995). Impedance measurement of growth of lactic acid bacteria in dairy cultures with honey addition. International Dairy Journal, 5, 727–733.

63. Czerniewicz, M., Kielczewska, K., & Kruk, A. (2006). Comparison of some physicochemical properties of milk from Holstein-Friesian and Jersey cows. *Polish journal of food and nutrition sciences*, *15*(1), 61.

64. Cziszter, L. T., Acatincăi, S., Neciu, F. C., Neamţ, R. I., Ilie, D. E., Costin, L. I. ... & Tripon, I. (2012). The influence of season on the cow milk quantity, quality and hygiene. *Scientific Papers: Animal Science and Biotechnologies*, *45*(2), 305-312.

65. Dahl, G. E., L. T. Chapin, M. S. Allen, W. M. Moseley, and H. A. Tucker. (1991). Comparison of somatotropin and growth hormonereleasing factor on milk yield, serum hormones, and energy status. J. Dairy Sci. 74:3421–3428.

66. Dalgleish, D. G. (1993). Bovine milk protein properties and the manufacturing quality of milk. *Livestock production science*, *35*(1-2), 75-93.

67. Daniel, J. B., Friggens, N. C., Van Laar, H., Ingvartsen, K. L., & Sauvant, D. (2018). Modeling homeorhetic trajectories of milk component yields, body composition and dry-matter intake in dairy cows: Influence of parity, milk production potential and breed. *animal*, *12*(6), 1182-1195.

68. De Jong, P. (1996). Modelling and optimization of thermal treatments in the dairy industry, Thesis, Technical University Delft, the Netherlands.

69. De Peters, E. J., & Ferguson, J. D. (1992). Nonprotein nitrogen and protein distribution in the milk of cows. *Journal of dairy science*, *75*(11), 3192-3209.

70. Debouz, A., Guerguer, L., Hamid Oudjana, A., & Hadj Seyd, A. E. K. (2014). Etude comparative de la qualité physico-chimique et microbiologique du lait de vache et du lait camelin dans la wilaya de Ghardaïa. *Revue ElWahat pour les Recherches et les Etudes*, *7*(2), 10-17.

71. Deeth, H. C., & Lewis, M. J. (2017).*High temperature processing of milk and milk products*. (H. C. Deeth & M. J. Lewis, Eds.) (First edi.). Chichester, UK: John Wiley & Sons Ltd.

72. Deeth, H. C., (2010). Improving UHT Processing and UHT Milk Products. In: M. W. Griffiths, ed.*Improving the safety and quality of milk | Volume 1: Milk production and processing.* Cambridge, UK: Woodhead Publishing Limited, pp. 302 - 329.

73. DeVries, J. W., & Silvera, K. R. (2000).and Chemical Components and Their Bioavailability. *Essentials of functional foods*, 99.

74. Dey, S., & Karim, M. H. (2013). Study on physicochemical and microbial quality of available raw, pasteurized and UHT milk during preservation. *International Journal of Science Inventions Today*, *2*(2), 150-7.

75. Dohoo, I. R., & Meek, A. H. (1982). Somatic cell counts in bovine milk. *The Canadian Veterinary Journal*, *23*(4), 119.

76. Dos Reis Coimbra, J. S., & Teixeira, J. A. (2016). *Engineering aspects of milk and dairy products*. CRC Press, pp.156.

77. Driehuis, F. (2013). Silage and the safety and quality of dairy foods : A review. Agricultural and Food Science 22 : 16-34.

78. Dubeuf, B., Coulon, J. B., & Landais, E. (1991). Mise à l'herbe des vaches laitières en zone de montagne : description des pratiques et liaison avec les performances laitières.

79. Dubey, J. P., M. C. Jenkins, D. S. Adams, M. M. Mc Allister, R. Anderson-Spnecher, T .V. Baszler, O. C. Kwok, N.C. Lally, C. Bjorkman and A. Uggla. (1997). Antibody responses of cow during an outbreak of neosporosis evaluated by indirect fluorescent antibody test and different enzyme-linked immunosorbent assays. J. Parasitol. 83:1063-1069.

80. Early, R. (Ed.). (1998). *Technology of dairy products*. Springer Science & Business Media.

81. El Hadi, A. (2015). Effect of shearing, during the milking period, on the lactational performances of two breeds of dairy ewes.

82. El-Hamdani, M., Zaaraoui, L., El Housni, A., Bendaou, M., Douaik, A., Zouahri, A. ... & Bouksaim, M. (2016). Seasonal effect on bovine raw milk composition of Oulmes local race in Morocco. *Food Science and Quality Management*, *52*, 49-55.

83. Enb, A., Abou Donia, M. A., Abd-Rabou, N. S., Abou-Arab, A. A. K., & El-Senaity, M. H. (2009). Chemical composition of raw milk and heavy metals behavior during processing of milk products. *Global Veterinaria*, *3*(3), 268-275.

84. Essalhi, M. (2002). Relations entre les systems de production bovines et les Caractéristiques du Lait. *Memoire D'ingénieur. Université institut Agronomiques et vétérinaire Hassan II. Rabat*, P104.

85. Fascar, I., & Ban, I. (1992). A new, portable electronic device for the early diagnosis of bovine mastitis. *Magyar Allatorvosok Lapja*, *47*(8), 418-422.

86. Ferlay, A., Martin, B., Pradel, P., Coulon, J. B., & Chilliard, Y. (2006). Influence of grass-based diets on milk fatty acid composition and milk lipolytic system in Tarentaise and Montbéliarde cow breeds. *Journal of dairy science*, *89*(10), 4026-4041.

87. Fernane, H., Touil, A. T., Benbarek, H., & Benchohra, M. (2016). Physicochemical Composition and Sanitary Quality of Pasteurized Milk Marketed in Western Algeria. *J. Appl. Environ. Biol. Sci*, *6*(12), 63-68.

88. Fitouhi, N., Gmar, M., Sboui, N., & Debbabi, H. (2018). Correlations between quality, enzymatic activities and storage stability of UHT milk in Tunisia. *Nature & Technology*, (18), 36-41.

89. Fonseca, L. F. L. ; Santos, M. V. (2000). Qualidade do leite e controle de mastite. Editorial Lemos, São Paulo.

90. Fowler, P. A., Knight, C. H., Cameron, G. G., & Foster, M. A. (1990). In-vivo studies of mammary development in the goat using magnetic resonance imaging (MRI). *Reproduction*, *89*(1), 367-375.

91. Fox Pf, Kelly Al (2004). The caseins', in Yada R (ed.), Proteins in Food Processing, Cambridge, Woodhead Publishing, 29+71.

92. **Fox, P. F. & McSweeney, P. L. H., (1998b).** Salts of milk. In: *Dairy Chemistry and Biochemistry.*1st ed. London, UK: Blackie Academic & Professional, pp. 239 - 264.

93. **Fox, P. F. (2009)**. Milk: An overview. Pages 1-53 in Milk Proteins - from Expression to Food. A.Thompson, M. Boland, and H. Singh, ed. Academic Press, New York.

94. **Fox, P. F., Mcsweeney, P. L., & Paul, L. H. (1998).** Dairy chemistry and biochemistry.

95. **Fox, P. F., Uniacke-Lowe, T., McSweeney, P. L. H., & O'Mahony, J. A. (2015)**. Milk proteins. In *Dairy chemistry and biochemistry* (pp. 148). Springer, Cham.

96. **Fredot, E. (2006).** Connaissance des aliments, ed. *Lavoisier, Paris, 397.*

97. **Friggens, N. C., Ridder, C., & Løvendahl, P. (2007).**On the use of milk composition measures to predict the energy balance of dairy cows. *Journal of Dairy Science*, *90*(12), 5453-5467.

98. **Gajbhiye, P. U. (2015).** Effect of season and stage of lactation on milk components of Jaffrabadi buffaloes. *The Bioscan*, *10*(2), 635-8.

99. **Garel, J. P., & Coulon, J. B. J. (1990).** Effet de l'alimentation et de la race des vaches sur la fabrication de fromage d'Auvergne de Saint-Nectaire. *Productions animales*, *3*(2), 127-136.

100. **Garza, C., Butte, N. F., Stuff, J. E., Motil, K. J., Montandon, C. M. &Schanier, R. J. (1986).** Estimating intakes of breastfed infants. In : The Breastfed Infant : A Model for Performance (Filer, L. J., Jr. &.Fomon, S. J., eds.|, pp. 6-12. Ross Laboratories, Columbus, OH.

101. **Gaucher, I., Mollé, D., Gagnaire, V. & Gaucheron, F. (2008)**. Effects of storage temperature on physico-chemical characteristics of semi-skimmed UHT milk. *Food Hydrocolloids*, 22(1), pp.130-143.

102. **Gaucheron, F. (2005).** The minerals of milk. *Reproduction Nutrition Development*, *45*(4), 473 483.

103. **Goff, H.D. & Griffiths, M.W. (2006).** Major advances in fresh milk and milk products: fluid milk and frozen desserts. *Journal of Dairy Science*, 89:1163–1173.

104. **Goff, H.D. and AR. Hill. (1993).** Dairy Chemistry and Physics. In: Dairy Science and Technology Handbook l. Principles and Properties (Hui). VCH Publishers, New York, pp: l-81.

105. **Gomez Barroso, B. (1997).** Effect of raw milk quality on keeping quality of pasteurized milk (Doctoral dissertation, MSc Dissertation, Department of Food Science and Technology, The University of Reading, Reading).

106. **Gonzalo, C., Blanco, A., Beneitez, E., Juarez, M T., Martinez, Linage, B., Ariznabarreta, A. (2005).** Qualité physico-chimique et hygiénique du lait de brebis chez les troupeaux du bassin de castilla-Léon (Espagne). Rens. Rech. Ruminants, 12, 401.

107. Goursaud, J. (1985). Milks of other animal species. *Laits et produits laitiers. Vache. Brebis. Chèvre. 1. Les laits. De la mamelle à la laiterie.*, 389-392.

108. Grewal, M. K. (2018). *Understanding and predicting storage stability of UHT milk* (Doctoral dissertation, Victoria University).

109. Griffiths, M. (Ed.). (2010). *Improving the safety and quality of milk: Milk production and processing*. Elsevier, pp 4-131.

110. Grummer, R. R. (1991). Effect of feed on the composition of milk fat. *Journal of dairy science*, *74*(9), 3244-3257.

111. Gueguen, L., Journet, M., & Langlois, M. (1961). Les variations de la composition minérale du lait de vache. In *Annales de Biologie Animale Biochimie Biophysique* (Vol. 1, No. 3, pp. 305-310). EDP Sciences.

112. Guetouache, M., Guessas, B., & Medjekal, S. (2014). Composition and nutritional value of raw milk. *J Issues Biol Sci Pharm Res*, *2350*, 1588.

113. Gulati, A., Galvin, N., Hennessy, D., McAuliffe, S., O'Donovan, M., McManus, J. J. ... & Guinee, T. P. (2018). Grazing of dairy cows on pasture versus indoor feeding on total mixed ration: Effects on low-moisture part-skim Mozzarella cheese yield and quality characteristics in mid and late lactation. *Journal of Dairy Science*, *101*(10), 8737-8756.

114. Gurmessa. J., & Melaku, A. (2012). Effect of lactation stage, pregnancy, parity and age on yield and major components of raw milk in bred cross Holstein Friesian cows. *World Journal of Dairy & Food Sciences*, *7*(2), 146-149.

115. Hagsten, C. (2016). Cleaning of ultra-high temperature milk fouling-Structural and compositionl changes. Lund University.

116. Hamad, M. N. E. F., Abdel-Kader, Y. I., & Shahin, M. A. H. (2017). Analysis of Representative Samples of UHT Sterilized Milk in the Egyptian Market. *American Journal of Food*, *2*(6), 31-42.

117. Hamann, J., & Zecconi, A. (1998). Evaluation of the electrical conductivity of milk as a mastitis indicator. *International Dairy Federation*.

118. Hamiroune, M., Dahmani, S., Kasmi, Z., Foughalia, A., & Djemal, M. (2019). Evaluation of the Physicochemical Quality of Raw Bovine and Goat Milk Marketed in the Steppic Region of Djelfa (Algeria). *Bulletin of the University of Agricultural Sciences & Veterinary Medicine Cluj-Napoca. Veterinary Medicine*, *76*(1)

119. Hansen, A. P., & Melo, T. S. (1977). Effect of ultra-high-temperature steam injection upon constituents of skim milk. *Journal of Dairy Science*, *60*(9), 1368-1373.

120. Haque, N., Hossain, S. K. A. and Singh M. (2017). Effect of management practices on milk yield and composition of lactating Murrah buffaloes during different seasons. Bull. Env. Pharmacol. Life Sci., 6(3): 447 – 450.

121. Harper, W. J. (1981). Advances in chemistry of milk. *Journal of Dairy Science*, *64*(6), 1028-1037.

122. Harris, B. and Bachman K. C. (2002). Nutritional and management factors affecting solids-not-fat, acidity and freezing point of milk. Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida. Publication number DS25.

123. Harsted, O. M. & Steinshamn, H., (2010). Cows' diet and milk composition. In: M. W. Griffiths, ed. *Improving the safety and quality of milk | Volume 1: Milk production and processing.*Cambridge, UK: Woodhead Publishing Limited, pp. 223-245.

124. Hassan, A. A., Akineden, O., & Usleber, E. (2005). Identification of Streptococcus canis isolated from milk of dairy cows with subclinical mastitis. *Journal of clinical microbiology*, *43*(3), 1234-1238.

125. Heins, B. J., Hansen, L. B., & Seykora, A. J. (2006). Calving difficulty and stillbirths of pure Holsteins versus crossbreds of Holstein with Normande, Montbeliarde, and Scandinavian Red. *Journal of Dairy Science*, *89*(7), 2805-2810.

126. Henno, M., Ots, M., Jõudu, I., Kaart, T., & Kärt, O. (2008). Factors affecting the freezing 502 point stability of milk from individual cows. International Dairy Journal, 18, 210-215

127. Hettinga, K. A., van Valenberg, H. J. F., Lam, T. J. G. M., & van Hooijdonk, A. C. M. (2009). The origin of the volatile metabolites found in mastitis milk. *Veterinary microbiology*, *137*(3-4), 384-387.

128. Hillerton, J. E., & Berry, E. A. (2004). Quality of the milk supply: European regulations versus practice. In *NMC Annual Meeting Proceedings* (Vol. 207, p. 214).

129. Hillerton, J. E., & Walton, A. W. (1991). Identification of subclinical mastitis with a hand-held electrical conductivity meter. *The Veterinary Record*, *128*(22), 513-515.

130. Hnini, R., Ouhida, L., Chigr, M., Merzouki, M., Gammouh, A., Najimi, M., & Chigr, F. (2018). Evaluation of the Physical and Chemical Quality of Moroccan Cow Raw Milk in Dairy Herds Located in the Beni Mellal Region. *World Journal of Research and Review*, 2455-3956.

131. Hoden A., Coulon J.B. et Faverdin P. (1988). Alimentation des bovins, ovins et caprins. In JARRIGE R. (Ed), INRA, Paris, France**, 135-158.**

132. Hodge, J. E. (1953). Dehydrated foods, chemistry of browning reactions in model systems. *Journal of agricultural and food chemistry*, *1*(15), 928-943.

133. Hotrum, N., Fox, M., van Lieverloo, H., Smit, E., de Jong, P., & Schutyser, M. (2010). Modelling heat processing of dairy products. In *improving the safety and quality of milk* (pp. 330-348). Woodhead Publishing.

134. Huppertz, T., & Kelly, A. L. (2009). Properties and constituents of cow's milk. *Milk processing and quality management*, 23.

135. IDF (International Dairy Federation) (1986) Cheese and Processed Cheese Product. Determination of Fat Content- Gravimetric Method (Reference Method). Standard FIL-IDF 5B: 1986. International Dairy Federation, Brussels, Belgium.

136. Imran, M., Khan, H., Hassan, S. S., & Khan, R. (2008). Physicochemical characteristics of various milk samples available in Pakistan. *Journal of Zhejiang University Science B*, *9*(7), 546-551.

137. Inagaki, M., Kawai, S., Ijier, X., Fukuoka, M., Yabe, T., Iwamoto, S., & Kanamaru, Y. (2017). Effects of heat treatment on conformation and cell growth activity of alpha-lactalbumin and beta-lactoglobulin from market milk. *Biomedical Research*, *38*(1), 53-59.

138. Jadhav, B. S., Kulkarni, M. B., & Chavan, K. D. (2008). Effect of lactation order and stage of lactation on physical properties of milk. *Journal of Dairying Foods & HS*, *27*(3/4), 168-174.

139. Jai, V. (2014). Seasonal variation of milk in central valley California and the association of milk variation with the composition and texture of low mositure part skim mozzarella.

140. Jensen, H. B., Poulsen, N. A., Andersen, K. K., Hammershøj, M., Poulsen, H. D., & Larsen, L. B. (2012). Distinct composition of bovine milk from Jersey and Holstein-Friesian cows with good, poor, or noncoagulation properties as reflected in protein genetic variants and isoforms. *Journal of Dairy Science*, *95*(12), 6905-6917.

141. Jónás, W., & Woodside, B. (2016). Physiological mechanisms, behavioral and psychological factors influencing the transfer of milk from mothers to their young. *Hormones and Behavior*, *77*, 167-181.

142. JORA (Journal Officiel de la République Algérienne). (1998). Ministerial DecreeMicrobiological specifications of certain foods. N°35.

143. JORA (Journal Officiel de la RepubliqueAlgerienne). (2004). Ministerial Decree. Making obligatory a microbiological control method in pasteurized milk. N°70, pp: 19-22.

144. Journet, M., & Chilliard, Y. (1985). Influence de l'alimentation sur la composition du lait. I. Taux butyreux facteurs generaux. *Bulletin Technique, Centre de Recherches Zootechniques et Vétérinaires de Theix*, (60), 13-23.

145. Kabil, O. I., Ali, M. A., Ibrahim, E., & El Barbary, H. A. (2015). Effect of seasonal variation on chemical composition of Cow's milk. *Benha Veterinary Medical Journal*, *28*(1), 150-154.

146. Kadzere, C. T., Murphy, M. R., Silanikove, N., & Maltz, E. (2002). Heat stress in lactating dairy cows: a review. *Livestock production science*, *77*(1), 59-91.

147. Kanwal, R., Ahmed, T., & Mirza, B. (2004). Comparative analysis of quality of milk collected from buffalo, cow, goat and sheep of Rawalpindi/Islamabad region in Pakistan. *Asian Journal of Plant Sciences*, *3*(3), 300-305.

148. Kanyeka, H. B. (2014). Assessment of microbial quality of raw cow's milk and antimicrobial susceptibility of selected milk-borne bacteria in Kilosa and Mvomero districts, Tanzania (Doctoral dissertation, Sokoine University of Agriculture).

149. Kaouche-Adjlane, S., & Mati, A. (2017). Effets des pratiques d'élevage sur la variation de la qualité hygiénique et nutritionnelle du lait cru dans la région médio-septentrionale d'Algérie. *Revue Méd. Vét*, *168*(7-9), 151-163.

150. Kasmi, H. Aggad, H., Belkhemas, A., Bouriah,N., &Bendif.,**H.(2022).**Relations between electrical conductivity, california mastitis test (CMT) and some physicochemical quality parameters in the diagnosis of subclinical mastitis in dairy cows in tiaret region, western algeria.International Journal of Ecosystems and Ecology Science12 (2).

151. Kasmi, H. Bouriah, N., Abd Daliim M., Acem K., Aggad, H., & Oueld Amar, I. (2021). Milk physicochemical parameters : Efficiency of Lactoscan.Lucrari Stintifice Mesecina Veterina, 3.

152. Kawkab Abdul Hussein, R., & Faisal Abboud, S. (2014). The Effect of Some Environmental Factors on the Chemical Composition in the Milk of Holstein Friesian Cows. *Al-Qadisiyah Journal for Agriculture Sciences*, *4*(2), 11-18.

153. Kędzierska-Matysek, M. O. N. I. K. A., Litwińczuk, Z., Florek, M., & Barłowska, J. (2011). The effects of breed and other factors on the composition and freezing point of cow's milk in Poland. *International Journal of Dairy Technology*, *64*(3), 336-342.

154. Kekan, P. M., Wankar, A. K., Daware, S. B., & Amrutkar, S. A. (2021). Effect of Seasons x Meteorological Variables on Normal Milk Constituents in Marathwadi Buffaloes. *Int. J. Curr. Microbiol. App. Sci*, *10*(02), 388-392.

155. **Kelly, A. L. & Larsen, L. B., (2010)**. Milk Biochemistry. In: M. W. Griffiths, ed. *Improving the safety and quality of milk | Volume 1: Milk production and processing.*Cambridge, UK: Woodhead Publishing Limited, pp. 3 - 16.

156. Kessler, H. G., (2002). Heat Treatment, Processes and Effects - Microorganisms and Conditions of Inactivation. In: *Food and Bio Process Engineering - Dairy Technology*.5 th ed. Munich, Germany: Verlag A. Kessler, pp. 130 - 216.

157. Kitchen, B. J. (1981). Bovine mastitis: milk compositional changes and related diagnostic tests. *Journal of Dairy Research*, *48*(1), 167-188.

158. Křížová, L., Hanuš, O., Hadrová, S., Kučera, J., Samková, E., Roubal, P., & Veselý, A. (2014). Composition, physical and technological properties of raw milk as affected by cattle breed, season and type of diet. *Ann Anim Sci*, *14*, 721-736.

159. Kumar, P., & Sandeep, K. P. (2014). Thermal principles and kinetics. *Processing: Principles and Applications, 2nd ed; Clark, S., Jung, S., Lamsal, B., Eds*, 17-31.

160. Laben, R. C. (1963). Factors responsible for variation in milk composition. *Journal of Dairy Science*, *46*(11), 1293-1301.

161. Labioui, H., Elmoualdi, L., Benzakour, A., El Yachioui, M., Berny, E., & Ouhssine, M. (2009). Etude physicochimique et microbiologique de laits crus. *Bull. Soc. Pharm. Bordeaux*, *148*(2009), 7-16.

162. Lansbergen, L. M. T. E., Nielen, M., Lam, T. J. G. M., Pengov, A., Schukken, Y. H., & Maatje, K. (1994). Evaluation of a prototype on-line electrical conductivity system for detection of subclinical mastitis. *Journal of Dairy Science*, *77*(4), 1132-1140.

163. Legarto, J., Gelé, M., Ferlay, A., Hurtaud, C., Lagriffoul, G., Palhiere, I., ... & Brunschwig, P. (2014). Effets des conduites d'élevage sur la production de lait, las taux butyreux et protéique et la composition en acides gras du lait de vache.

164. Lewis, M. (2010). Improving pasteurised and extended shelf-life milk. In *improving the safety and quality of milk* (pp. 277-301). Woodhead Publishing.

165. Lewis, M. J., & Deeth, H. C. (2009). Heat treatment of milk. *Milk processing and quality management*, 168-204.

166. Leymarios, F. C. (2010). Nutritional quality of cow's milk and its fatty acids. PhD thesis. National veterinary School of alfort, France, pp. 122.

167. Li, S., Ye, A., & Singh, H. (2019). Seasonal variations in composition, properties, and heat-induced changes in bovine milk in a seasonal calving system. *Journal of dairy science*, *102*(9), 7747-7759.

168. Lien, S., J. Kantanen, I. Olsaker, L.-E. Holm, E. Eythorsdottir, K. Sandberg, B. Dalsgard, and S. Adalsteinsson. (1999). Comparisonof milk protein allele frequencies in Nordic cattle breeds. Anim.Genet. 30:85–91.

169. Lock, A. L., & Garnsworthy, P. C. (2003). Seasonal variation in milk conjugated linoleic acid and Δ9-desaturase activity in dairy cows. *Livestock Production Science, 79*(1), 47-59.

170. Lohaj, S. (2020). Effect of seasons on bulk milk quality in ferizaj province. *International Journal of Food Technology and Nutrition*, *3*(5-6), 47-55.

171. Looper, M. L. (2012). Factors affecting milk composition of lactating cows.

172. Lorenzen, P. C., Clawin-Rädecker, I. N. G. R. I. D., Einhoff, K., Hammer, P., Hartmann, R., Hoffmann, W., ... & Devrese, M. (2011). A survey of the quality of extended shelf life (ESL) milk in relation to HTST and UHT milk. *International journal of dairy technology, 64*(2), 166-178.

173. Lounis, M., & Harfouche, L. (2020). Physicochemical characteristics of raw milk marketed in the city of Djelfa, Algeria. *Agricultura*.

174. Lucey, J. A., & Horne, D. S. (2009). Milk salts: Technological significance. In *advanced dairy chemistry* (pp. 351-389). Springer, New York, NY.

175. Luquet, F.M., (1985). Milks and dairy products (cow, ewe, goat. Milk from udder to dairy

176. M., Kawai, S., Ijier, X., Fukuoka, M., Yabe, T., Iwamoto, S., & Kanamaru, Y. (2017). Effects of heat treatment on conformation and cell growth activity of alpha-lactalbumin and beta-lactoglobulin from market milk. *Biomedical Research*, *38*(1), 53-59.

177. M.A.D.R.P, (2015). Evolution du cheptel bovin, de la production laitière et de la collecte en Algérie.

178. Mabrook, M. F., & Petty, M. C. (2003). Effect of composition on the electrical conductance of milk. *Journal of food engineering*, *60*(3), 321-325.

179. Madhu, (2021). what is the Difference between HTST and LTLT. *https://www.differencebetween.com/what-is-the-difference-between-htst-and-ltlt. Visited in September 23 rd, 2022.*

180. Madsen, B. D., Rasmussen, M. D., Nielsen, M. O., Wiking, L., & Larsen, L. B. (2004). Physical properties of mammary secretions in relation to chemical changes during transition from colostrum to milk. *Journal of dairy research*, *71*(3), 263-272.

181. Malek dos Reis, C. B., Barreiro, J. R., Mestieri, L., Porcionato, M. A. D. F., & dos Santos, M. V. (2013). Effect of somatic cell count and mastitis pathogens on milk composition in Gyr cows. *BMC veterinary research*, *9*(1), 1-7.

182. Malmgren, B. (2007). Evaluation of UHT milk processed by direct steam injection and steam infusion technology.

183. Mansour, L. (2015). Etude de l'influence des pratiques d'élevage sur la qualité du lait : effet de l'alimentation.Thése de doctorat.

184. Matallah, S., Bouchelaghem, S., & Matallah, F. (2015). Variations de la composition chimique du lait de vache Holstein dans le nord-est de l'Algérie. *Livestock Research for Rural Development*, *27*(1).

185. Matallah, S., Matallah, F., Djedidi, I., Mostefaoui, K. N., & Boukhris, R. (2017). Qualités physico-chimique et microbiologique de laits crus de vaches élevées en extensif au Nord-Est Algérien. *Livestock Research for Rural Development*, *29*(11).

186. Mc Kinnon, I.R.; Yap, S.E.; Augustin, M.A. and Hermar, Y. (2009). Diffusing-wave spectroscopy investigation of heated reconstituted skim milks containing calcium chloride. Food Hydrocolloids, 23, 1127–1133.

187. Mchiouer, K., Bennani, S., El-Gendy, N. S., & Meziane, M. (2017). Evaluation of the hygienic quality of raw cow's milk in Oujda city Morocco. *Biosciences Biotechnology Research Asia*, *14*(2), 587-591.

188. Mehta, R. S. (1980). Milk processed at ultra-high-temperatures–a review. *Journal of Food Protection*, *43*(3), 212-225.

189. Meklati, F. R., Meribai, A., & Ben-Mahdi, M. H. (2017). Lactation stage effect on nutritional quality of Algiers area cows' milk.

190. Meribai, A. (2015). *Influence de quelques paramètres de production sur la composition physico-chimique du lait et aptitude technologique* (Doctoral dissertation).

191. Meunier-Goddik, L., & Sandra, S. (2002). Liquid milk products/pasteurized milk. Encyclopedia of dairy sciences. Amsterdam: Academic Press, 3, 1627-1632.

192. Miglior, F., Sewalem, A., Jamrozik, J., Lefebvre, D. M., & Moore, R. K. (2006). Analysis of milk urea nitrogen, lactose, and their effect on longevity in Canadian dairy cattle. *Journal of Dairy Science, 89*(12), 4886-4894.

193. Milkotronic, Ltd. (2019). Ultrasonic milk analyzer (operation manual).pp .08.Website: www.lactoscan.com.

194. Mocanu, G. D., Andronoiu, D. G., Nistor, O. V., & Botez, E. (2011). Quality control of raw cow milk from Galati county. *J. Agroaliment. Proc. Technol*, *17*(3), 303-7.

195. Mucchetti, G., Gatti, M., & Neviani, E. (1994). Electrical conductivity changes in milk caused by acidification: determining factors. *Journal of dairy science*, *77*(4), 940-944.

196. Mushtaq, A. (2009). Effect of Physiological states on milk fatty acids profile in dairy cows and buffaloes (Doctoral dissertation, Agricultural University, Peshawar).

197. Myer, Phillip R., Kyle R. Parker., Andrew T. Kanach., Tengliang Zhu., Mark T. Morgan & Bruce M. Applegate. (2016). The effect of a novel low temperature-short time (LTST) process to extend the shelf life of fluid milk. Doi: 10.1186/s40064-016-2250-1.

198. Nantapo, C. T. W., Muchenje, V., & Hugo, A. (2014). Atherogenicity index and health-related fatty acids in different stages of lactation from Friesian, Jersey and Friesian× Jersey cross cow milk under a pasture-based dairy system. *Food Chemistry*, *146*, 127-133.

199. Neba, S. R. (2015). An Analysis of Milk Chemical Composition Produced from Malawi Zebu-Friesian Crosses Raised Under Small Scale Systems, Their Susceptibility to Environmental Stress and Prevalence of Subclinical Mastitis.

200. Nero, L. A., & De Carvalho, A. F. (Eds.). (2018). Raw milk: balance between hazards and benefits. Academic Press.

201. Neville, M. C. (1995). The physical properties of human and bovine milks. *Hand Book of Milk Composition*, pp 82.

202. Neville, M. C. (2005). Calcium secretion into milk. *Journal of mammary gland biology and neoplasia*, *10*(2), 119-128.

203. Neville, M. C., Morton, J., & Umemura, S. (2001). Lactogenesis: the transition from pregnancy to lactation. *Pediatric Clinics of North America*, *48*(1), 35-52.

204. Nielen, M., Deluyker, H., Schukken, Y. H., & Brand, A. (1992). Electrical conductivity of milk: measurement, modifiers, and Meta analysis of mastitis detection performance. *Journal of Dairy Science*, *75*(2), 606-614.

205. Nolan, D. T. (2020). The Economics of Milk Quality Management Practices and Milk Pricing in Simulated United States Dairy Herds.

206. Norberg, E., Hogeveen, H., Korsgaard, I. R., Friggens, N. C., Sloth, K. H. M. N., & Løvendahl, P. (2004). Electrical conductivity of milk: ability to predict mastitis status. *Journal of dairy science*, *87*(4), 1099-1107.

207. O'Callaghan, T. F., Sugrue, I., Hill, C., Ross, R. P., & Stanton, C. (2019). Nutritional aspects of raw milk: a beneficial or hazardous food choice. In *raw milk* (pp. 127-148). Academic Press

208. O'Mahony, F., 1998. Rural Dairy Technology- Experiences in Ethiopia. ILCA manual No 4. Dairy Technology Unit. ILCA, Addis Abeba, Ethiopia.

209. Orloff, S. L., J. C. Wallinford, and J. S. Mcdougal. (1993). Inactivation of human inmunodeficiency virus type 1 in human milk: Effects of intrinsic factors in human milk and of pasteurization. J. Hum.Lact. 9:13–17.

210. Osman ALatta, M.A. (2017) .Effect of Different Stages of the Lactation Period on Physicochemical Properties of Camel, Goat and Cow Milk (Doctoral dissertation, Sudan University of Science and Technology).

211. Osman, A. M. (2006). Dairy Technology, Handouts for Graduate Studies, Collage of Vet. Med Animal Production, Sudan.University of Science and Technology, Khartoum, Sudan.

212. Ozrenk, E., & Inci, S. S. (2008). The effect of seasonal variation on the composition of cow milk in Van Province. *Pakistan Journal of nutrition*, *7*(1), 161-164.

213. Packard, V., Ginn, R. (1990). An evaluation of freezing point changes in raw milk analyzed by Dairy Quality. Dairy, Food and Environmental Sanitation, 10: 347-351.

214. Palmquist, D. L., Beaulieu, A. D., & Barbano, D. M. (1993). Feed and animal factors influencing milk fat composition. *Journal of dairy science, 76*(6), 1753-1771.

215. Pandey, G. S., & Voskuil, G. C. S. (2011). Manual on milk safety, quality and hygiene. *Golden Valley agricultural Research Trust, Zambia*, *52*.

216. Parmar, P., Lopez-Villalobos, N., Tobin, J. T., Murphy, E., McDonagh, A., Crowley, S. V., & Shalloo, L. (2020). The effect of compositional changes due to seasonal variation on milk density and the determination of season-based density conversion factors for use in the dairy industry. *Foods, 9*(8), 1004.

217. Patbandha, T. K., Ravikala, K., Maharana, B. R., Marandi, S., Ahlawat, A. R., & Gajbhiye, P. U. (2015). Effect of season and stage of lactation on milk components of Jaffrabadi buffaloes. *The Bioscan*, *10*(2), 635-8.

218. **Patton, S. (2004).**Milk: It is Remarkable Contribution to Human Health and Well-being.New Brunswick, New Jersey: Transaction Publishers.

219. Pennington, J. A. (2008). Applications of food composition data: data sources and considerations for use. Journal of Food Composition and Analysis, 21, S3-S12.

220. Pinkerton, F., & Peters, I. I. (1958). Conductivity, percent lactose, and freezing point of milk. *Journal of Dairy Science*, *41*(3), 392-397.

221. Pirlo, G., Miglior, F., & Speroni, M. (2000). Effect of age at first calving on production traits and on difference between milk yield returns and rearing costs in Italian Holsteins. *Journal of dairy science*, *83*(3), 603-608.

222. Pollott, G. E. (2004). Deconstructing milk yield and composition during lactation using biologically based lactation models. *Journal of dairy science*, *87*(8), 2375-2387.

223. Ponce P. and R. Hernández. (2001). Physical-chemical properties of milk and its association with metabolic disorders and alterations in the mammary gland. In: Use of milk to monitor the nutrition and metabolism of dairy cows. Federal University of Rio Grande do Sul, Porto Alegre. pp. 58-68

224. Pond, C. M. (1977). The significance of lactation in the evolution of mammals. *Evolution*, 177-199.

225. Prodhan, U. K., Alam, M. J., Sadia, M. K., Sultana, S., Hye, M. A., & Ahamed, M. S. (2016). Study on the quality of commercial market milk available in Bangladesh. *Annals Food Science and Technology*, *17*, 293-298.

226. Radostits, O. M., Leslie, K. E., & Fetrow, J. (1994). Herd health: food animal production medicine (No. Ed. 2). WB Saunders Company.

227. Rajčević, M., Potočnik, K., & Levstek, J. (2003). Correlations between somatic cells count and milk composition with regard to the season. *Agriculturae Conspectus Scientificus*, *68*(3), 221-226.

228. Rakib.H.R. (2013). Turbidity index for the detection of heated milk .Thesis Bangladesh Agricultural University.

229. Ramet, J. P., & Organisation des Nations Unies pour l'alimentation et l'agriculture. (1985). La fromagerie et les variétés de fromages du bassin méditerranéen. Organisation des nations unies pour L'Alimentation et L'Agriculture.

230. Ravanis, S., & Lewis, M. J. (1995). Observations on the effect of raw milk quality on the keeping quality of pasteurized milk. *Letters in Applied Microbiology*, *20*(3), 164-167.

231. Ravikala, K., Patbandha, T. K., & Vataliya, P. H. (2014). Nutritional management of dairy animals through milk yield and its component evaluation. In *Annual Convention of Indian Society of Animal Production and Management* (pp. 137-144).

232. Raynal-Ljutovac, K., Park, Y., Gaucheron, F. & Bouhallab, S. (2007). Heat stability and enzymatic modifications of goat and sheep milk. *Small Ruminant Research*, 68:207–220.

233. Remeuf, F., Lenoir, J., Duby, C., Letilly, M. T., & Normand, A. (1989). Etude des relations entre les caractéristiques physico-chimiques des laits de chèvre et leur aptitude à la coagulation par la présure. *Le Lait*, *69*(6), 499-518.

234. Renhe, I. R. T., Perrone, Í. T., Tavares, G. M., Schuck, P., & de Carvalho, A. F. (2019). Physicochemical characteristics of raw milk. In *raw milk* (pp. 29-43). Academic Press.

235. Riet Sapriza, F. G. (2007). Milk composition of the New Zealand sea lion and factors that influence it: a thesis presented in partial fulfilment of the requirements for the degree of Doctor of Philosophy in Zoology at Massey University, Palmerston North, New Zealand.

236. Robertson, G.L. (2006) *Food Packaging: Principles and Practice*, 2nd edn, pp. 255–270, Taylor &Francis, Boca Raton, FL.

237. Rutz, W. D., Whitnah, C. H., & Baetz, G. D. (1955). Some physical properties of milk. I. Density. *Journal of Dairy Science*, *38*(12), 1312-1318.

238. Ryley J, Kaida P. (1994). Vitamins in thermal processing. Food Chemistry 49:119-29.

239. Saadi, A. M., & Hasan, G. M. (2019). The Effect of Nutrition and the Seasons of the Year on the Composition of Cow's Milk in Two Different Areas of the Province of Mosul. *Annals of Agri-Bio Research*, *24*(1), 148-152.

240. Sahib, L., Pramod, S., Becha, B. B., Joseph, A. P., & Venkatachalapathy, R. T. (2019). Influence of Pregnancy, Parity and Stage of Lactation on Milk Yield and Composition in Crossbred Dairy Cattle. *Journal of Animal Research*, *9*(6), 945-947.

241. Sarfraz , A., Gaucher, I., Rousseau, F., Beaucher, E., Piot, M., Grongnet, J. F., & Gaucheron, F. (2008). Effects of acidification on physico-chemical characteristics of buffalo milk: A comparison with cow's milk. *Food chemistry*, *106*(1), 11-17.

242. Sassi, E., (2019). Etude de la variation saisonnière des paramètres biochimiques et microbiologiques du lait cru de vache à la traite dans l'Ouest Algérien (Doctoral dissertation, Universite Abdelhamid Ibn Badis–Mostaganem).

243. Sboui, A., Khorchani, T., Djegham, M., & Belhadj, O. (2009). Comparaison de la composition physicochimique du lait camelin ET bovin du Sud tunisien; variation du pH ET de l'acidité à différentes températures. *Afrique science : revue internationale des sciences et technologie*, *5*(2).

244. Schroeder, C., Horner, S., Bürger, N., Engemann, C., Bange, U., Knoop, E. V., & Gabert, J. (2012). Improving the sensitivity of the IBR-gE ELISA for testing IBR marker vaccinated cows from bulk milk. *Berliner Und Munchener Tierarztliche Wochenschrift*, *125*(7-8), 290-296.

245. Sebbane, H., Almi, D., Hadouchi, S., Hedjel, L., Smail-Saadoun, N., & Mati, A. (2021). Microbiological and physicochemical changes during ripening of Camembert cheeses made from raw and pasteurized cow milk produced in Tizi-Ouzou (north of Algeria). *Indian J Dairy Sci*, *74*(1), 18-29.

246. Senter, S. D. (1970). *Chemical and physical changes resulting from UHT treatment of milk* (Doctoral dissertation, Virginia Polytechnic Institute and State University).

247. Sevi, A., Albenzio, M., Marino, R., Santillo, A., & Muscio, A. (2004). Effects of lambing season and stage of lactation on ewe's milk quality. *Small Ruminant Research*, *51*(3), 251-259.

248. Sheldrake, R. F., Hoare, R. J. T., & McGregor, G. D. (1983). Lactation stage, parity, and infection affecting somatic cells, electrical conductivity, and serum albumin in milk. *Journal of Dairy Science*, *66*(3), 542-547.

249. Short, A. L. (1955). The temperature coefficient of expansion of raw milk. *Journal of dairy Research*, *22*(1), 69-73.

250. Shuiep, E. S., El Zubeir, I. E. M., El Owni, O. A. O., & Musa, H. H. (2008). Influence of season and management on composition of raw camel (Camelus dromedarius) milk in Khartoum state, Sudan. *Tropical and subtropical Agroecosystems*, *8*(1), 101-106.

251. Shuiep, E. S., Eltaher, H. A., & El Zubeir, I. E. M. (2016). Effect of stage of lactation and order of parity on milk composition and daily milk yield among local and crossbred cows in South Darfur State, Sudan.

252. Singh, H., 1993. *Heat-induced Interactions of Proteins in Milk.* Munich, Germany, International Dairy Federation Special Issue No.9303, pp. 191-204.

253. Sissao, M., Millogo, V., & Ouedraogo, G. A. (2015). Composition chimique et qualité bactériologique des laits crus et pasteurisés au Burkina Faso. *Afrique Science : Revue Internationale des Sciences et Technologie*, *11*(1), 142-154.

254. Smit, L. E., Schönfeldt, H. C., de Beer, W. H., & Smith, M. F. (2000). The effect of locality and season on the composition of South African whole milk. Journal of food composition and analysis, 13(4), 345-367.

255. Sodini, I., Remeuf, F., Haddad, S., & Corrieu, G. (2004). The relative effect of milk base, starter, and process on yogurt texture: a review. *Critical reviews in food science and nutrition*, *44*(2), 113-137.

256. Sourabh, Y. (2016). Effect of season, lactation and parity on yield and major components of raw milk in crossbred Holstein-Friesian cows. *International Journal of Agriculture Sciences, ISSN*, 0975-3710.Soyeurt, H., Gillon, A., Vanderick, S., Mayeres, P., Bertozzi, C., & Gengler, N. (2007). Estimation of heritability and genetic correlations for the major fatty acids in bovine milk. *Journal of Dairy Science*, *90*(9), 4435-4442.

257. Sraïri M T, Hasni Alaoui I, Hamama A et Faye B. (2005). Relations entre pratiques d'élevage et qualité globale du lait de vache en étables suburbaines au Maroc. Revue de Médecine vétérinaire 156, 155-162.

258. Sraïri, M.T; Benhouda, H; Kuper, M. and Le Gal, P.Y. (2009). Effect of cattle management practices on raw milk quality on farms operating in a two-stage dairy chain. Trop. Anim. Health Prod., 41:259-272.

259. Stanton, T. L., Jones, L. R., Everett, R. W., & Kachman, S. D. (1992). Estimating milk, fat, and protein lactation curves with a test day model. *Journal of dairy science*, *75*(6), 1691-1700.

260. Stoop, W. M., Bovenhuis, H., Heck, J. M. L., & Van Arendonk, J. A. M. (2009). Effect of lactation stage and energy status on milk fat composition of Holstein-Friesian cows. *Journal of dairy science*, *92*(4), 1469-1478.

261. Sudhakar, K., Panneerselvam, S., Thiruvenkadan, A. K., Abraham, J., & Vinodkumar, G. (2013). Factors effecting milk composition of crossbred dairy cattle in Southern India. *International Journal of Food, Agriculture and Veterinary Sciences*, *3*(1), 229-233.

262. Sundekilde, U. K. (2012). Milk Metabolite Variability, Heritability, and Their Association with Technological Properties of Bovine Milk Elucidated by NMR-based Metabonomics: PhD Thesis: Science and Technology. Aarhus University, Department of Food Science.

263. Sutton, J. D. (1989). Altering milk composition by feeding. *Journal of dairy science*, *72*(10), 2801-2814.

264. Tadjine, D., Boudalia, S., Bousbia, A., Khelifa, R., Mebirouk Boudechiche, L., Tadjine, A., & Chemmam, M. (2019). Pasteurization effects on yield and physicochemical parameters of cheese in cow and goat milk. *Food Science and Technology*, *40*, 580-587.

265. Tallini, R. A. (2015). Effects of pasteurization and ultra-high temperature processes on proximate composition and fatty acid profile in bovine milk. *American Journal of Food Technology*, *10*(6), 265-272.

266. Tamine, A.Y. (2009). Milk processing and quality management, Society of Dairy Technology (SDS) series. Wiley-Blackwell. pp .29-87.

267. Teshome, D. (2018). College of Natural and Computational Sciences Center for Food Science and Nutrition (Doctoral dissertation, Addis Ababa University).

268. Tir E., Samira, B., Messaouda, H., & Nassira, B. (2015). Etude de la qualité physico-chimique et microbiologique de laits crus de vache dans deux fermes de la wilaya de Tissemsilt (Algérie). *Revue ElWahat pour les Recherches et les Etudes*, *8*(2), 26-33.

269. Toledo, R. T., Singh, R. K., & Kong, F. (2007). *Fundamentals of food process engineering* (Vol. 297). New York: Springer.

270. Tsioulpas, A., Grandison, A. S., & Lewis, M. J. (2007). Changes in physical properties of bovine milk from the colostrum period to early lactation. *Journal of dairy science*, *90*(11), 5012-5017.

271. Ueda, A. (1999). *Relationship among milk density, composition, and temperature* (Doctoral dissertation, University of Guelph).

272. Updegrove, K. (2005). Human milk banking in the United States. *Newborn and Infant Nursing Reviews*, *5*(1), 27-33.

273. Van Boekel, M. A. J. S. (1998). Effect of heating on Maillard reaction in milk. *Food Chemistry*, *62*(4), 403–414.

274. Vertes, C., Hoden, A., & Gallard, Y. (1989). Effet du niveau d'alimentation sur la composition chimique et la qualité fromagère du lait de vaches Holstein et Normandes. Résultats préliminaires.

275. Vignola, C. L. (2002). Science and technology of milk: milk processing. *Science and technology of milk: milk processing.*

276. Walstra, P. & Jenness, R. ***(1984).*** *Dairy Chemistry and Physics.* John Wiley & Sons, NewYork.

277. Walstra, P., Wouster, J. T. M., & Geurts, T. J. (2006). *Dairy Science and Technology* (2nd Ed). Boca Raton, US: Taylor & Francis.

278. Walstra, P., Wouters, J. T., & Geurts, T. J. (2005). *Dairy science and technology*: CRC press.

279. Walzel, R. (1997). Auswirkungen eines Mastitiskontrollprogramms in oberschwäbischen Milchviehbetrieben.Diss. med. vet., München, Germany

280. Webb, B. H., & Johnson, A. H. (1965). Fundamentals of dairy chemistry. *Fundamentals of dairy chemistry.*Webb, B.H., A.H. Johnson and J.A. Alford. 1974. Fundamentals of Dairy Chemistry. 3rd ed.Chapman & Hall, London, New York.

281. Wolter, R. (1997). *Alimentation de la vache laitière*. France Agricole Editions.Wong, N. P. 1988. Physical Properties of Milk. Page 409 in Fundamentalsof Dairy Chemistry. 3rd ed. N. P. Wong, ed. Van NostrandReinhold Co., New York, NY.

282. Yagoub, S. O., Bellow, F. A., & El Zubeir, I. E. M. (2008). Effect of temperature and storage period on the constituents of milk inoculated with Pseudomonas Aeruginosa. *Research Journal of Microbiology*, *3*(1), 30-34.

283. Yildirim, S., & Cimen, M. (2009). Biochemical factors affecting taste of milks from machine milking. *Asian Journal of Chemistry*, *21*(3), 2457.

284. Yoon, J. T., Lee, J. H., Kim, C. K., Chung, Y. C., & Kim, C. H. (2004). Effects of milk production, season, parity and lactation period on variations of milk urea nitrogen concentration and milk components of Holstein dairy cows. *Asian-australasian journal of animal sciences*, *17*(4), 479-484.

285. Zagorska, J., & Ciprovica, I. (2013). Evaluation of factors affecting freezing point of milk. *International Journal of Nutrition and Food Engineering*, *7*(2), 106-111.

286. Zaman, M. A., Ara, A., & Haque, M. N. (2016). Effect of season on production and quality of milk of crossbred dairy cows at Sylhet district government dairy farm in Bangladesh. *Bangladesh Journal of Animal Science*, *45*(3), 52-57.

287. Zitoun, O. A., Benatallah, L., Ghennam, E., & Zidoune, M. N. (2011). Manufacture and characteristics of the traditional Algerian ripened bouhezza cheese. *Journal of Food, Agriculture & Environment*, *9*(2 part 1), 96-100.

APPENDIX

APPENDIX

Appendix I: Preliminary investigation

Farm: ☐

Number of cow: ☐

Breed:

Local: ☐

Imported: ☐

Lactation:

Number of lactation: ☐

Stage of lactation: ☐

Dry period: ☐

Calving :

Number of calvings: ☐

Calving season: ☐

Score body: ☐ **/05**

Milk yield: ☐ **/Day**

The state of health:

Mastitis: ☐

Metritis: ☐

Lameness: ☐

Livestock management:

feeding:

Green Forage ☐

Dry forage ☐

Concentrate ☐

CMV ☐

Watering: ad libitum ☐ Assist ☐

Milking: Manuel ☐ Mechanical ☐

Clinical examination of the mammary gland Inspection:

Volume :

Atrophy ☐ Hypertrophy ☐

Balance ☐ Imbalance ☐

Palpation :

Consistency :

Normale ☐ rough ☐

Appendix II:

International Journal of Ecosystems and Ecology Science (IJEES) Vol. 11 (4): 867-872 (2021)
https://doi.org/10.31407/ijees https://doi.org/10.31407/ijees11.4

EFFECT OF THE SEASON AND THE STAGE OF LACTATION ON THE PHYSICOCHEMICAL PROPERTIES OF HOLSTEIN'S COW MILK IN TIARET, ALGERIA

Amina Belkhemas[1*], Abdellatif Niar[1], Bouabdellah Benallou[2], Mohamed Benahmed[1]

[1]Nature and Life Sciences Faculty, University of Tiaret (14000), Algeria;*
[2]Farm Animal Reproduction Laboratory, Veterinary Institute, University of Tiaret (14000), Algeria;

[*]Corresponding author Amina Belkhemas, e-mail: amina.belkhemas@univ-tiaret.dz;

Received June 2021; Accepted July 2021; Published September 2021;

DOI: https://doi.org/10.31407/ijees11.425

ABSTRACT

The current study aimed to determine the effect of season and lactation stages on certain physico-chemical parameters in Holstein crossbred cows in Tiaret city (Algerian west high lands). A total of 245 milk samples from 45 cows were analyzed by lactoscan SP in two seasons (spring and winter), and from different stage of lactation (early, mid and late). The results showed that all the chemical constituents were higher in the spring and lower in winter, with no significant difference. However, the season had a significant influence on milk conductivity ($p < 0.05$). On the other hand, Fat was the only component that was highly significantly affected by the lactation stage ($p < 0.001$). Further, there was an increase in protein, fat, SNF, and conductivity values during the progress of lactation, unlike the values of lactose and density that decrease when the lactation stage progresses.

Key words: Holstein cows, season, stage of lactation, physico-chemical parameters

INTRODUCTION

Milk is an essential source of functional and healthy food ingredients (Batool et al. 2012). It is a comprehensive diet made up of a complex mixture of fat, proteins, carbohydrates, minerals, vitamins, and other miscellaneous components dispersed in water (Haug et al. 2007).

Furthermore, milk composition quality is very important in dairy technology, as it shows the ability to process milk (Ozrenk and SelcukInci, 2008). However, different factors affect the characteristics of milk, including season, breed, stage of lactation, parity, feeding and cow health (Fox and Mc Sweeney, 1998).
Given the importance of cow milk in Algeria and the country's urgent shortage of milk and dairy products, it's vital to comprehend the non-genetic factors that influence milk yield as well as the primary milk components to be able to take effective measures.

In this regard, the current study aimed to determine the impact of the lactation stage and seasonal changes in the physicochemical quality of raw Holstein cows milk, in the city of Tiaret (Algeria).

MATERIAL AND METHODS

From December 2020 to June 2021, our research were carried out in Tiaret City, during the two seasons of winter and spring. Over a period of six months, 245 raw milk samples were obtained from 45 imported cross-breed cows.

All of the cows believe to the same breed (Holstein), the same age, the same number of lactations, and belonging to the same farm. All animals were fed as per season, water was accessible ad libitum.

Sampling:
In the early morning, our milk samples were collected in bottles, and then were labeled and placed in an icebox, and immediately transported for their physico-chemical analysis in our laboratory (*Farm Animal Reproduction*).

Physico-chemical analysis:
In order to determine the chemical composition and the physical properties, all the samples were analyzed by Lactoscan SP (Milcotronic, Bulgaria). These parameters comprise: lactose (g/l), proteins (g/l), solids not fat (g/l), fat (g/l), density (kg/m3) and conductivity (mS/cm).

Statistical Analysis:
The mean, standard error, maximal and minimal values for each parameter were calculated, and a statistical analysis was performed using SPSS IMB 24 and the ANOVA1 test to identify the influence of season and stage of lactation.

RESULTS

Physicochemical Analysis:
Results of the physicochemical analysis of milk samples are shown in the table 1.

Table 1. The Physico-chemical composition of raw cow milk.

Parameters	mean	standard error	Minimum	Maximum
Fat (g/l)	15,15	0,59	1,00	51,20
Lactose (g/l)	53,17	0,28	5,00	61,90
Proteins (g/l)	35,36	0,19	3,73	41,30
SNF (g/l)	96,86	0,35	79,00	112,40
Density (kg/m3)	1035,21	0,17	1023,00	1040,59
Conductivity (mS/cm)	5,18	0,03	4,21	6,76

SNF: Solid non fat.

The average fat content with the standard error of all samples was 15,15±0,59 g/l for lactose, protein and SNF components were 53,17±0,82g/l, 35,36±0,19 g/l,96,86±0,35g/l, respectively. In addition, the mean value of the density was estimated at 1035, 21 ± .17 kg/m^3, while conductivity average value was of about 5, 18 ± 0,03 mS/cm.

Effect of season on Physico-chemical Properties
Seasonal changes in the composition of milk are shown in Table 2.

Table 2. Effects of the season on milk composition characteristics (Mean ± SE) and signification.

International Journal of Ecosystems and Ecology Science (IJEES) **Vol. 11 (4):** 867-872 (2021)
https://doi.org/10.31407/ijees https://doi.org/10.31407/ijees11.4

Factors	Winter			Spring			SIG
Fat (g/l)	14,15	±	0,82	16,23	±	0,85	0,080
Lactose (g/l)	53,07	±	0,27	53,28	±	0,50	0,702
Proteins (g/l)	35,30	±	0,19	35,43	±	0,33	0,718
SNF (g/l)	96,47	±	0,49	97,27	±	0,51	0,255
Density (g/l)	1035,27	±	0,21	1035,14	±	0,26	0,692
Conductivity (mS/cm)	5,25	±	0,04	5,10	±	0,04	0,007

The most important values were registered during the spring. Moreover, there was no significant variation between the two season's of winter and spring for all content.
In contrast, the least density was observed in the spring, at 1035,14 ± 0,26kg/m^3, while the maximum density was seen in the winter at 1035,27 ± 0,21kg/m^3 with an insignificant difference between the milk of the two seasons.
Further, a significant difference was recorded between the seasons of winter (5.25 ± 0.04% mS/cm) and spring (5.10 ± 0.04 mS/cm) for conductivity ($p<0.05$).

Effect of lactation stage on Physico-chemical Properties:

Table 3 shows the physico-chemical parameters of raw milk samples from Holstein cows at various stages of lactation.

Table 3. Effects of stage of lactation on milk composition characteristics (Mean ± SE) and signification.

Factors	Early lactation				Mid Lactation				Late lactation				SIG
Fat (g/l)	12,45	±	0,96	a	14,13	±	1,06	a	18,04	±	0,97	b	0,000
Lactose (g/l)	53,39	±	0,33	a	53,13	±	0,60	a	53,03	±	0,34	a	0,875
Proteins (g/l)	34,96	±	0,47	a	35,26	±	0,24	a	35,75	±	0,22	a	0,191
SNF (g/l)	96,29	±	0,60	a	96,96	±	0,64	a	97,23	±	0,59	a	0,529
Density (g/l)	1035,34	±	0,26	a	1035,32	±	0,30	a	1035,02	±	0,30	a	0,660
Conductivity (mS/cm)	5,13	±	0,05	a	5,13	±	0,05	a	5,24	±	0,05	a	0,154

Values with different letters in the same line differ considerably from one another

At the different stages of lactation, all of the physico-chemical features of Holstein cows raw milk samples observed in this investigation were insignificantly different (P>0.05), except for the fat content that was significantly highly different < (P0.001).

Furthermore, the amount of fat increased significantly < (P: 0.001) from early to late lactation. There was a significant difference amongst early and late and mid and late lactation respectively, whereas a non-significant difference was observed between the early and mid-lactation stages.
In addition, the highest levels of SNF values (97, 23 ± 0, 59 g/l) and proteins values (35, 75 ± 0, 22 g/l) were observed in the late stage of lactation. While the highest lactose contents (53, 39 ± 0,33g/l) were recorded in early lactation.

On the other hand, there was no substantial lactation stage effect on physical parameters (density and conductivity) (P>0.05).

Discussion

The present study investigated the influence of the season and lactation stage, on milk composition in dairy cows. The highest fat content was registered during spring than in winter. A similar result was reported by Matallah et al. (2015), and by Sassi et al. (2019). Generally, grazing at the end of the winter and in the spring increases the fat content (Coulon et al. 1986). The results of this research showed that the month of lactation have a highly significant effect on Fat content ($p < 0.001$). Similarly, in the studies of Meribai et al. (2015); Legarto et al. (2014) and Benyounes et al. (2013), it was shown that the lactation time had a substantial influence on milk fat content, and that fat content rose as the lactation period. However, Bohmanova et al. (2009) found reduced milk fat in late-lactation. The decreased milk fat concentration during early lactation and progressive increase as lactation progress could be related to milk production, since both are negatively correlated (Soltner, 1993; Belhadi et Amrane, 2011).

As expected, our results revealed no significant effect of the season on lactose content. Sassi et al. (2019) have observed similar findings. The results of the current study also showed that the lactation stage did not have a significant effect on the concentration of lactose in milk. It was shown to be decreased in the late stages of lactation. This is in agreement with the results mentioned by Houaga et al. (2018). Nevertheless, Benyounes et al. (2013) discovered lower milk lactose levels in early lactation. The synthesis of lactose is highly correlated to the quantity of water dragged into milk. Lactose and water secretion rates are virtually constant in lactation (Pollott, 2004).
In general, a positive correlation exists between the amount of milk proteins and the amount of milk fat (Hoden et al. 1985; Agabriel et al. 1993). Protein values in raw milk samples analyzed in this research were highest in spring which is consistent with the findings of Matallah et al. (2015), and Sassi et al. (2019). Furthermore, we did not find a significant difference across lactation phases. Houaga et al. (2018) have also discovered a similar result, whereas Meribai et al. (2015) and Benyounes et al. (2013) found a significant augmentation of proteins content during the lactation stage. It is worth noting that the protein content is related to race, udder health, lactation, season, and a number of layouts (Asif and Sumaira. 2010; Debbouze et al. 2014).
For the SNF, the values reported being lower in winter. El-Hamdani et al. (2016) reported similar results in Oulmes local cows. Furthermore, as the stage of lactation progressed, the amount of SNF increased, which is consistent with the findings of Meklati et al. (2017) and Meribai et al. (2015). However, Shuiep et al. (2016) found lower-level in late-lactation. The variations in SNF can be ascribed largely to changes in protein and on rare occasions, to lactose content of milk (Kekan et al. 2021).

Regarding density, the highest value was obtained for the winter season. These results also align with Sassi et al. (2019). Moreover, we found that the density values were decreased during the progress of lactation. However, Meklati et al. (2017) and Benyounes et al. (2013) reported higher values in late-lactation. The density of milk is dependent on fat, dry matter, temperature, and the diet of the animal (Matallah et al. 2017).
Seasonal fluctuations cause significant changes in the conductivity of raw milk decreasing as the season progresses. These findings are also similar to those found in Oulmes local cows (El-Hamdani et al. 2016). Milk conductivity varies widely between breeds and individuals within the same breed, as well as based on food, lactation stage, the temperature of the milk, the amount of fat in the milk, and the amount of time between two milking, according to Hamann and Zecconi (1998).

CONCLUSION

- ✓ The current study found that the chemical composition of Holstein cow's milk was unaffected by the season of the year, with only a minor rise in spring. Nevertheless, the seasonal variations have had a significant impact on raw milk's conductivity.
- ✓ In our study, the stage of lactation shows a significant effect on fat content. Moreover, protein, fat and solid not fat (SNF) contents increased, whereas the lactose value decreased as the lactation progress. Additionally, the physical properties of the study samples were less affected by the lactation stage.
- ✓ Ultimately, non-genetic variables have an impact on dairy quality, which will be taken into account during manufacturing dairy products since high-quality dairy products require high-quality raw milk.

REFERENCES

International Journal of Ecosystems and Ecology Science (IJEES) **Vol. 11 (4):** 867-872 (2021)
https://doi.org/10.31407/ijees https://doi.org/10.31407/ijees11.4

1. Agabriel C, Coulon J -B, Marty G, Bonaiti B, (1993). Facteurs de variations de la composition du lait dans des exploitations à haut niveau de production, INRA Production Animales 6 (1), 53-60;
2. Asif M, Sumaira U, (2010). A Comparative study on the physicochemical parameters of milk samples collected from buffalo, cow, goat and sheep of Gujrat, Pakistan, Pakistan Journal of Nutrition 9(12), 1192-1197;
3. Batool S-A, Kalsoom R, Rauf N, Tahir S-S, Hussain F, (2012). Microbial and Physico-Chemical Quality Assessment of the Raw and Pasteurized Milk Supplied In the Locality of Twin City of Pakistan, Internet Journal of Food Safety 14,17-22;
4. Belhadi N, Amrane R, (2011). Etude de quelques facteurs de variation de la production et la qualité du lait de vache au niveau de six élevages dans la wilaya de Tizi-Ouzou, Algérie. Le premier séminaire national : le lait et ses dérivés : entre réalité de production et réalités de transformation et de consommation. Université 8 mai 1945 de Guelma, Algérie, 4 et 5 octobre 2011;
5. Benyounes A, Bouriache H- E, Lamrani F, (2013). Effect of stage of lactation on the physical-chemical quality of milk from Holstein cows in the eastern region of Algeria. Livestock Research for Rural Development 25,7;
6. Bohmanova J, Jamrozik J, Miglior F, (2009). Effect of pregnancy on production traits of Canadian Holstein cows,Journal of Dairy Science 92(6), 2947- 2959;
7. Coulon J- B, Garel J- P, Hoden A, (1986). Evolution de la production et de la composition du lait à la mise à herbe, Bulletin Technique, Centre de Recherches Zootechniques et Vétérinaires de Theix 66, 23-29;
8. Debouz, A., Guerguer, L., Hamid Oudjana, A., & Hadj Seyd, A. E. K. (2014). Etude comparative de la qualité physico-chimique et microbiologique du lait de vache et du lait camelin dans la wilaya de Ghardaïa. Revue ElWahat pour les Recherches et les Etudes, 7(2), 10-17;
9. El-Hamdani M, Zaaraoui L, El Housni A, Bendaou M, Douaik A, Zouahri A, ... & Bouksaim M, (2016). Seasonal effect on bovine raw milk composition of Oulmes local race in Morocco,Food Science and Quality Management 52, 49-55;
10. Fox P- F, McSweeney P- L,Paul L- H,(1998). Dairy Chemistry and Biochemistry;
11. Hamann J, Zecconi A, (1998). Evaluation of the electrical conductivity of milk as a mastitis indicator, International Dairy Federation ;
12. Haug A, Hostmark A-T, Harstad O-M, (2007). Bovine milk in human nutrition – a review, Lipids in Health and Disease 6, 1-16;
13. Hoden A, Coulon J –B, Dulphy J- P (1985). Influence de l'alimentation sur la composition du lait. Effets des régimes alimentaires sur les taux butyreux et protéiques, Bulletin Technique, Centre de Recherches Zootechniques et Vétérinaires de Theix.62, 69-79;
14. Houaga I, Muigai A, Salifou C, Idrissou S, Kassa K, Sidi S, Hogbonouto E, ... & and Youssao I, (2018).Effect of herd, age, parity and stage of lactation on milk production traits in indigenous borgou cattle breed in benin,Int. J. Adv. Res 6(5), 92-100;
15. Kekan P.-M, Wankar A- K, Daware S.-B, Amrutkar S- A, (2021). Effect of Seasons x Meteorological Variables on Normal Milk Constituents in Marathwadi Buffaloes, Int. J. Curr. Microbiol. App. Sci 10(02), 388-392;
16. Legarto J, Gele M, Ferlay A, Berthou C, Lagriffoul G, Palhiere I, ... & Brunschwig P, (2014). Effets des conduites d'élevage sur la production de lait, les taux butyreux et protéique et la composition en acides gras du lait de vache, chèvre et brebis évaluée par spectrométrie dans le moyen infrarouge, INRA Productions Animales 27(4), 269-282;
17. Matallah S, Bouchelaghem S, Matallah F, (2015). Variations de la composition chimique du lait de vache Holstein dans le nord-est de l'Algérie, Livestock Research for Rural Development 27(1);
18. Matallah S, Matallah F, Djedidi I, Mostefaoui K, Boukhris R, (2017). Qualités physico-chimique et microbiologique de laits crus de vaches élevées en extensif au Nord-Est Algérien, Livestock Research for Rural Development 29(11);
19. Meklati F.-R, Meribai A, Ben-Mahdi M- H, (2017). Lactation stage effect on nutritional quality of Algiers area cows'milk,Int.J.Dairy Sci 12(3),236-242;
20. Meribai A, (2015). Influence de quelques paramètres de production sur la composition physico-chimique du lait et aptitude technologique, Doctoral dissertation;

21. Ozrenk E, Selcuk Inci S, (2008). The Effect of seasonal variation on the composition of cow milk in Van Province, Pakistan Journal of Nutrition 7, 161- 164;
22. Pollott G-E, (2004). Deconstructing milk yield and composition during lactation using biologically based lactation models,Journal Dairy Science 87,2375- 2387;
23. Sassi E, (2019). L'étude de la variation saisonnière des paramètres biochimiques et microbiologiques du lait cru de vache à la traite dans l'Ouest Algérien, Doctoral dissertation, Université de Mostaganem-Abdelhamid Ibn Badis;
24. Shuiep E- S, Eltaher H- A, El Zubeir I-E-M, (2016). Effect of stage of lactation and order of parity on milk composition and daily milk yield among local and crossbred cows in South Darfur State, Sudan, Journal of Agricultural and Veterinary Sciences 17(2);
25. Soltner D, (1993). La reproduction des animaux domestiques d'élevage, Zootechnie générale, Tome 1, deuxième Edition, collection sciences et technique agricole, pp. 232;