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Comparative Study on The Physiochemical and Nutritional Properties of Fresh Milk Samples Collected from Farms Animals in Benghazi City, Libya

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ABSTRACT

Milks in general is a complex system of colloidal dispersion of different components including minerals, carbohydrates, proteins and fats as major components and other minor components. The milk quality and nutritional contents can be demonstrated by evaluating the physiochemical properties of milk. This work carried out to evaluate and compare some physiochemical parameters and nutritional properties of fresh milk samples collected, from four animal species named cows, camels, goats and sheep, from different farms in Benghazi city, the eastern part of Libya and analysed for the following parameters: pH, acidity, solid non-fat contents, specific density, water, ash, lactose, proteins and fats. The results of physiochemical properties showed that the highest pH and acidity was for goat milk (6.65 and 0.031%) respectively. While the highest solid nonfat content was for sheep milk (12.96 %) and the highest specific density was for cow milk (1.502 g/cm3). The results of nutritional contents analysis showed that the sheep milk had the highest ash, lactose, total proteins (TP) and fats contents (0.87%), (7%), (5%) and (9%) respectively. While the cow milk had the highest water contents (88%). The physiochemical properties and nutritional contents of milk samples vary according to animal species. The values of physiochemical properties, and nutritional contents, that obtained in this study were in agreement with the values of the same properties published in some international studies.

دراسة مقارنة للخصائص الفيزيوكيميائية والغذائية لعينات الحليب الطازج التي تم جمعها من حيو انات المزارع في مدينة بنغازي، ليبيا

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الكلمات المفتاحية:
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المحتوى الغذائي
الحيوانات المزرعة

الملخص

يعتبر الحليب معلق غروي معقد، يحتوي على مكونات رئيسية مختلفة منها المعادن والكربوهيدرات والبروتينات والدهون. ويمكن تقييم جودة الحليب من خلال تعيين الخصائص الفيزيوكيميائية والمحتويات الغذائية للحليب. في هذه الدراسة تم جمع عينات حليب من أربعة أنواع حيوانية وهي الأبقار والإبل والماعز والأغنام، من مزارع مختلفة في مدينة بنغازي، شرق ليبيا. وهدفت الدراسة لتعيين بعض الخصائص الفيزيوكيميائية والمحتويات الغذائية لجميع عينات الحليب (الأس الهيدروجيني، الحموضة، الكثافة النوعية، والمواد الصلبة غير الدهنية ومحتوى كلاً من الرماد، الماء، سكر اللاكتوز، الدهون والبروتينات. أظهرت النتائج أن أعلى قيمة للأس الهيدروجيني وللحموضة كانت لحليب الماعز (6.65 و0.031%) على التوالي. بينما كان أعلى محتوى خالي من الدسم لحليب الأغنام (12.96٪) وأعلى كثافة نوعية كانت لحليب البقر (1.502 جم / سم3). كما أظهرت

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نتائج تحليل المحتويات الغذائية أن حليب الأغنام احتوى على أعلى محتوى من الرماد واللاكتوز والبروتينات والدهون الكلية (0.87٪) و (7٪) و (5٪) و (9٪) على التوالي. بينما احتوى حليب البقر على أعلى محتوى مائي (88٪). ولقد دلت نتائج الدراسة علي اختلاف الخصائص الفيزيوكيميائية والمحتويات الغذائية للحليب باختلاف أنواع الحيوانات. كما اتفقت القيم المتحصل عليها في هذه الدراسة مع بعض القيم المنشورة في دراسات عالمية.

I. Introduction

The history of milk started in Neolithic age, a period of time when the humans begin to settle and stop the gathering and hunting. In which, the human accepts new opportunities to acquire food. Among these recourses and in addition to the development of agriculture, the animal's domestication provided a constant access to the animals' fur, meat and mainly milk. The first animals to be domesticated were cows, goats, and sheep started 11,000 years ago in the middle East [1].

During the last centuries, the main source of nutritious foods was dairy products and milk, mainly for children as they contain micro- and macro-nutrients, that are important for bone development, growth and immune functions of the human body and animals [2]. Milk is considered as an important part of humans' diet. The milk contains a broad range of vital dietary components including water, minerals, lactose, proteins, fats and vitamins in well-adjusted ratio more than any other foods [3], [4].

The compositions of fresh milks differ according to numerous factors such as animal species, breed, udder health and feeding regimes [5]. In which, the daily consumptions of an approximately a liter of raw milk provides all the daily supplies of calcium, fat, riboflavin, phosphorus, one third of vitamin (A), one half of the proteins, thiamine, ascorbic acid and one fourth of calories required by a regular individual [6].

In addition, numerous mammals' milk is used to manufacturing a wide range of dairy products such as butter, milk cream, sour milk, ghee, yogurt and other products. These dairy products and nutritionally enriched milk besides, cows, goats and sheep milks are demanded by consumers on daily basis [7]. The milk of cows is consumed by millions on daily basis and considered as a very valuable and nutritious food. The milk of goats are different from human or cow milk in having better alkalinity, buffering capacity and digestibility. Goats is considered as cows of poor man as they provide the nutrition to rural poor and landless people [6].

In the arid countries and hot regions, the camel milk has an important role in human nutrition [8]. The camel milk consumption is common in Middle east and North Africa for therapeutic properties and nutritional properties as it is rich in unsaturated fatty acids [9].

Camel milk contains the same nutrients as the cow milk. In Saudi Arabia, camel milk is consumed as soured and fresh milk. In addition, in different regions of world including Sudan, Russia and India, the fermented and fresh camel milk is used to treat a series of diseases like tuberculosis, jaundice, asthma, dropsy and leishmaniasis [8].

Recently, the camel milk is used to treat many diseases [10]. Including cancer, diabetes and allergy as it has a hypoallergic properties [9]. This hypoallergic properties is linked to low content of B-lactoglobulin, B-casein and other components such as immunoglobulins, lactoferrin, lysozyme, and vitamin C that is considered as a key component in determination of these properties [9].

In general, the term of raw milk quality has a very wide meaning. This term includes such milk characteristics as physical properties, chemical composition, cytological and microbiological quality, technological suitability, nutritive value and sensory properties. The most important way to evaluate the quality of dairy products is the analysis of physicochemical properties [11]. Also, they are used to determine the milk component concentration [12].

The aim of this work is to compare the physiochemical parameters and nutritional contents of different fresh milk samples collected from four animals' species from different farms in Benghazi city.

Experimental Work

2.1. Reagents and chemicals

Reagents and chemicals used in this work are of analytical grads and the water was deionized double distilled water.

2.2. Milk samples collection and handling

The fresh milk samples of cows, camels, goats and sheep were collected from 10 randomly selected farms in Benghazi city. The fresh milk samples of four animals' species were collected in the period from January to April 2018. The samples were collected for each animal separately and then mixed in separate clean bottles. The samples before the analysis were well mixed and checked for odor, color and impurity were filtered if have been found.

2.3. Milk Analysis

The physicochemical and nutritional properties of milk were determined according to the method of Association of Official Analytical Chemists (AOAC) [13]. The pH values were measured using a digital pH-meter ((*Ino lab WTW*) equipped with glass combined electrode (*pH-electrode sen Tix* 61-*B*023009*AP*017) calibrated with pH 4 and 7 buffers. Titratable acidity and water content were determined by direct titrimetric and evaporating methods, respectively. Specific gravity was determined using pycnometer. Ash content was determined by gravimetric method using a muffle furnace (Model ELF11/14, 1100°C, Keison, UK) [13]. The nutrition analysis of fresh milk samples was carried out by LactoStar Milk Analyzer (device Lactostar 3510- series by Funke-Dr. N. Gerber Labortechnik GmbH, Germany), that adopts the thermal and optical procedures to analysed the milk samples. The LactoStar device is directly measured fat and solid non fat (SNF) contents, then calculate protein and lactose contents [14], [15]. According to manufacturer's instructions of LactoStar, milk samples were mixed gently to avoid any air enclosure in the milk. Then 25 ml samples were taken in the sample-tube and placed instrument sensor. As the starting button activated, the analyzer sucks the milk and makes the measurements.

The total protein (TP) content of milk samples were estimated by determining the nitrogen content of each sample using Kjeldahl method [13]. In this method 2.5g of milk sample was weighted and placed in a Kjeldahl flask, then 0.5mg of mercuric oxide, 10g of potassium sulphate and 20mL of sulphuric acid were added and heated for 6min. After digestion process, the mixture was distilled in presence of sodium hydroxide solution and the evolved ammonia was recovered in 20% boric acid solution. The quantity of ammonia was determined by titration with standard hydrochloric acid solution. The TP content in milk sample was calculated by multiplying the total nitrogen content in 6.38.

For determination of casein protein (CP) content of milk sample, casein is firstly precipitated from milk at pH 4.6 using acetic acid and sodium acetate solutions in Kjeldahl flask. The nitrogen content of casein precipitate is determined as above procedure, using Kjeldahl method and multiplied by 6.38 to obtain casein content in milk samples. The whey protein (WP) contents of milk samples were estimated by evaluating the difference between total protein content and casein content [13].

2.4. Statistical analysis

The analysis of each milk sample was performed in triplicate and the results were expressed as the mean values with standard deviation (mean ±SD) of w/w%. The statistical analysis was performed using Statistical Package for Social Sciences (SPSS program, version 21). The one-way analysis of variance (ANOVA) test was used to calculate the difference between means using Least Significant Difference (LSD) test at level of significance $p < 0.05$.

Results and Discussion

3.1. The physiochemical properties of fresh milk

In this study the physiochemical properties of cows, camels, goats and sheep's' fresh milk samples collected from randomly selected farms in Benghazi city were measured at ambient room temperature (25°C). The measured physiochemical properties of fresh milk sample were pH, acidity, nonfat content and specific density, which illustrated in average values in Table 1.

Table 1: The physiochemical properties of cows, camels, goats and sheep's' fresh milk

Property	Fresh milk of Farm Animals			
	Cow	Camel	Goat	Sheep
pH	6.61	6.32	6.65	6.59
Acidity (%)	0.021	0.028	0.031	0.024
solid Nonfat (%)	7.75	8.62	9.53	12.96
Specific density (g/cm^3)	1.052	1.039	1.031	1.025

3.1.1. The pH values of fresh milk samples

The pH values of the fresh milk samples were in range of 6.61-6.65 that are slightly acidic in nature. In particular, the goat milk has the highest pH value (6.65) and the pH values of cow and sheep milks were close to each other (6.61) and (6.59) respectively. While, the camel milk has the lowest pH values (6.32) and it is statistically different from the pH values of cow, goat and sheep fresh milk samples.

In this study, the average pH values of fresh cow and goat milk samples were in the range of pH values of fresh milk samples of the same animals' species measured and reported by Imran *et al*. [16]. But, the average pH values of cow, camels and goats' milks in our study was lower than the average pH values of milk samples of the same animals' species measured in Afghanistan [17]. While, the average pH values of camel milk of our study full in the range of pH values (6.2-6.5) of camels' fresh milks as stated by Gul *et al*. [10].

3.1.2. Titratable acidity of fresh milk samples

The measurement of acidity is a measure of milk bacterial contents and the freshness of milk samples [18]. The acidity of fresh milk samples ranges from 0.021%-0.032%. In which, the cow milk has the lowest acidity (0.021%) and goat milk has the highest acidity (0.032 %). While, the sheep milk and camel milk had the acidity values (0.024%) and (0.028%) respectively.

However, the lower average acidity values of fresh milk samples of the cow, goat and sheep is higher than the average acidity values of fresh milk samples of the same animals' species measured in Kanwal *et al*. work [19].

3.1.3. The nonfat solid contents of fresh milk samples

The results of fresh milk samples analysis showed that the nonfat solid contents have wide concentration range from (7.75%) to (12.96%). In which, the highest solid nonfat contents were in sheep milk (12.96%) then goat milk (9.53), camel milk (8.62%) and finally cow milk (7.75%) in decreasing order.

3.1.4. The specific density contents of fresh milk samples

The specific density of fresh milk samples was different from each other in which the cow milk has the highest density (1.052 g/cm^3) and the sheep milk has the lowest density (1.025 g/cm^3). while, the camel milk has specific density (1.039 g/cm^3) higher than that for goat milk (1.031 g/cm^3).

The average specific density value of goats' fresh milk is in agreement with the specific density values published by Mahmood and Sumaira [6]. While, the value of average specific density of cows' fresh milks is higher than the value of specific density in the same study. The average specific gravity of sheep's fresh milk is close to the specific gravity values of sheep fresh milk (1.28g/cm^3) stated in Kanwal *et al*. work [19].

The average value of specific density of camel milk is slightly higher than the range of specific density measured for camel milk (1.026-1.035) in Kula & Tegegne work [20]. According to many studies there are many factors affect the compositions of camel milk including; feeding conditions, physiological stage or seasonal variation, health genetic status of camel, the geographical origin and period of working [21].

3.2. The nutritional contents of fresh milk samples

The nutritional contents of fresh milk samples of cows, camels, goats and sheep were measured as well at ambient room temperature (25°C) and the results illustrated in Table 2.

Table 2: The nutritional contents of fresh milk samples

Milk Sample	Water (%)	Ash (%)	Lactose (%)	Fats (%)
Cow	88 ±11	0.66 ±0.012	4 ±0.4	3 ±0.9
Camel	87 ±5.6	0.73 ±0.010	5 ±0.2	4 ±0.6
Goat	83 ±13	0.79 ±0.012	6 ±1.2	6 ±1.1
Sheep	78 ±18	0.87 ±0.055	7 ±1.2	9 ±1.3

3.2.1. The water content of fresh milk samples

The water content of fresh milk samples under investigation were 88%. 87%. 83% and 78% for cow milk, camel milk, goat milk and sheep milk respectively as shown in Table 2. The water contents of cow and camel milks are nearly comparable (88%) and (87%) respectively. Whereas, the sheep milk had the lowest water contents (78%) and this decrease is not a statistically significant. Also, this decrease was obvious from the values of specific density of sheep milk.

The water contents of cow milks came in accordance with the findings of Lee and lucey, 2004 [22]. While, the water contents of goats and sheep's fresh milks samples are lower and higher respectively than the values of water contents published by Balthazar *et al.* for fresh milks samples of the same animals' species [23].

3.2.2. Ash contents of fresh milk samples

The water contained in milk or any other food is removed by evaporation and the residue is incinerated to a white or nearly white ash containing minerals [19].The ash contents of fresh milk were obtained by burning samples at (500-600°C) for two hours. The results showed that the ash content of sheep fresh milk was the highest. While, the ash content of other fresh milk samples in increasing order were 0.66%, 0.73% and 0.79% for cow, camel and goat milks respectively.

The ash contents of cows and goats' fresh milks samples are in agreement with the values of ash contents stated in Imran *et al*. and Balthazar *et al*. works [16, 23]. Whereas, the ash content of sheep fresh milk is lower than the value of ash content reported in Balthazar*et al*. work for fresh sheep milks (0.9%±0.1 g/100g) [23].

3.2.3. The Lactose content of fresh milk samples

The main carbohydrate of milk is lactose [18]. The results of our fresh milk samples showed that the lactose contents of sheep milk were the highest. While, the lactose contents of other fresh milk samples of cow, camel and goat were close to each other (4%), (5%) and (6%) respectively. The content of lactose of sheep milk was not significantly different, in comparable to fresh milk of other animals.

The lactose contents of cow, camel fresh milk samples were an approximately comparable with the values of lactose contents of the same animal's species (4.6%) and (4.53%) for cow and camel respectively as reported by Musallam *et al*. [24]. Also, in this work

the lactose content of fresh goat milk is higher than the lactose contents of goat milk (4.39%) reported in Musallam *et al*. work for goat fresh milk. On other hand, the content of lactose in sheep fresh milk is higher than the values of lactose in fresh sheep milks(4.8±0.4 g/100g) estimated in Balthazar *et al*. work [23].

3.2.4. The fats content of fresh milk samples

The obtained results showed that the fat contents of cow and camel milk are close to each other's (3%) and (4%) respectively. While, the fat contents of goat milk (6%) were higher than the fat contents of camel milk but without any statistically significant different. The sheep milk has the highest fat contents (9%) but has no statistically significant different with the content of fats in the fresh milk samples of cow and camel. Also, there is no statistically significant different between the values of fat contents in both cows and goats fresh milk samples (Table 2).

The values of fats contents are higher for goat and lower for cows' fresh milks samples than the results reported for the same animals' species in Sudan [25]. While, the amount of fats in sheep's fresh milk is much higher than the values of fats in fresh sheep milk as stated in Balthazar *et al*. work [23].

3.2.5. The total proteins content of fresh milk samples

The TP contents of fresh milk samples were close to each other's, Fig 1. The lowest TPs content was for cow milk (3%) and it is close to the TP contents of camel fresh milk samples (3.5%) and this decrease has no statistically significant difference with the total protein contents of goat (4%) and camel milk samples. Whereas, the TPs contents of sheep milk samples were the highest (5%) and this increase is statistically significant difference from the total protein's values of cow's milk.

The TPs contents of fresh cow and goat milks samples were both slightly lower than the protein contents values of the same animal species (4.25%) and (4.93%) for cow and goat respectively as stated by Musallam *et al*. [24]. Also, the TPs content of the camel fresh milk samples was close to the protein content of fresh camel milk samples (2.89%) in the same study. Whereas, the sheep's milk proteins content is in agreement the value of proteins presented for sheep fresh milk (5.5±1.1 g/100g) in Balthazar *et al*. work [23].

The concentration of TP and CP were determined by formal methods and then the concentration of WP was measured for all types and illustrated in Fig 1. The results for cow fresh milk samples were 3.14%, 2.48%, and 0.66% respectively. In camel milk they were 3.49%, 2.74% and 0.74% respectively. In goat milks they were 3.88%, 3.09% and 0.79%, respectively and in sheep milk they were 5.28%, 4.19% and 1.09%, respectively (Fig. 1).

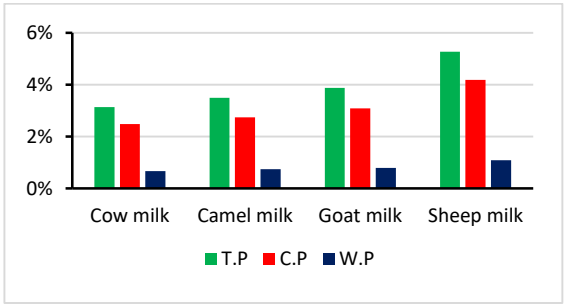

Fig. 1: The concentration of total protein, casein and whey proteins of cows, camels, goats and sheep milks

Generally, the nutritional contents of cow milks were water (88%), ash (0.66 %), lactose (4%), TPs (3%) and fats (3%). The nutritional contents of goat milk were water (83%), ash (0.79 %), lactose (6%), TP (4%) and fats (6%). The nutritional contents of sheep milk were water (78%), ash (0.87 %), lactose (7%), TP (5%) and fats (9%). The average values of camel milk nutritional components in our study are comparable for water content, lower in ash contents, higher in lactose contents, similar in TPs contents and slightly lower in fats contents than the average values stated in Al Kanhal work [8]. In which, the water covers 87%, ash 0.73%, lactose 5%, TPs 3.5%, and fat 4%.

Conclusion

The current study has been showed that the physiochemical properties and nutritional contents of fresh milks samples vary according to animal species, which is considered as milk profile markers help people choosing the best milk according to their needs of different nutrients. In addition, this study showed that all types of fresh milk samples contain the required nutrients for daily human consumption. Also, further studies shouled be done to determine the viscosity, rheology and the studies of nutritional values of different fresh milk samples of these animal species during different seasons.

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