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Girolando and Borgou Cow's Milk: Physico-chemical and Nutritional Characterization

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Abstract The aim of this study is to evaluate the physio-chemical and nutritional potentials of raw milk from Girolando and Borgou species of cow in South of Benin. For this purpose, different physical chemistry techniques were used on 10 samples of raw cow milk's from Girolando breed and 10 others from Borgou breed. Results show that the majority of analyzed parameters comply with food standards, except the titratable acidity values for both milk variety and vitamins content for Girolando breed. There were no significant differences between: Density, Fat content, Total carbohydrates, Proteins and Magnesium contents of the two milks. However, there is a significant difference for Borgou cow's milk content of mineral except for sodium content which has high rate in the milk of Girolando's cows (0.6042±0.039g/kg). Moreover, cow milk from Borgou is particularly richer in vitamin B2 (405.97±32.57g/kg) than the one of Girolando. The outcomes of this research could serve as a reference for nutritionists in their quest for balanced diet composition and editing of their teachings and communications.

Keywords: *food safety, milk, nutrients, physico-chemistry*

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1. Introduction

Milk is recognized as a complete food which composition is essential for human health. Besides its general need for human health, milk provides proteins for proper growth of infants and adults [1]. In Benin, the contribution of the livestock sub-sector to agricultural increased from 2.88% to 15.5% in 2011 and then to 18.5% in 2014. The level reached in 2014 is higher than the 2015 target of 16% [2]. In this country, milk production is important both from a food and an economic point of view. It contributes more than 50% to the annual income of Fulani households [3]. On a national cattle herd estimated in 2015 at 2,420,898 head, total milk production is estimated at 109,660,194 liters [4]. This milk production is still insufficient and only partially covers the animal protein needs of the populations. Therefore, the country finds itself as an importer of milk and dairy products. The quantity of milk imported from 2012 to 2014 increased from 12,000 to 16,250 tons [5]. To meet the food needs of a growing population while limiting the import of milk and dairy products, Benin republic in 2004 and 2014 has introduced the Girolando cows at Kpinnou Breeding Farm [6]. Girolando were imported from Brazil and is known for its high dairy production (4.82 liters of milk per day) contrary to the local breed (Borgou) [7]. This potential leads Fulani women in the Mono region to become more interested in cow's milk of the Girolando breed for cheese (Waragashi) production. However, what are the qualitative performance of both races of cattle breed? Works such as those of [8] compared the nutritional and sanitary quality of milk from different breeds of cows in some breeding areas of Benin. These authors showed that there is a significant difference between the protein and mineral content (iron, zinc, magnesium, potassium, calcium) of milk from these two breeds of cattle. Milk is a food consumed by both children and adults; it would therefore be interesting to study the nutritional intake of milk of both breeds of cows for the well-being of the population. It is for this purpose that the present study was initiated on the physico-chemical and nutritional characterization of the two types of milk.

2. Materials and Methods

2.1. Animals for Experimentation

The raw milk collected comes from ten (10) Borgou cows and ten (10) Girolando cows raised in Kpinnou farm one of the largest farms in Benin. This farm is located in the commune of Athieme in the department of Mono in

southern Benin. It covers an area of 380 hectares and extends between 0°51'30 "and 1°53'30" east longitude then between 6°35'40" and 6°48'40" north latitude. The study area is characterized by a Subequatorial climate, two (02) dry seasons and two (02) rainy seasons, with an average rainfall of 900 and 1100 mm per year.

The cows being milked were all in good health and benefited from Trypamidium blood washing and internal deworming with Benzal. They graze for six hours a day on an artificial pasture composed mainly of *Panicum maximum* var. C1.

2.2. Milk Milking

The milking was done manually and very early in the morning on cows at 4 years of age and at the second calving with no history of dystocia, agalactia, mastitis or abortion.

2.3. Physico-chemical Properties Characterization of Milks

The pH of the raw milks was measured "*in situ*" using a portable digital pH-meter (Hanna instruments, HI8014). The titratable acidity was determined by an acid-base titration in the presence of soda and phenolphthalein as a colored indicator. The dry matter (DM) content was determined according to the standard NF V 04- 207.

2.4. Nutritional Characterization of Milks

Fat content was determined by Röse-Gottlieb's method. Nitrogen content was found by Kjeldahl method in order to get the percentage in proteins following this rule:

$$\%\ Proteins = \%\ Nitrogen * 6.38$$

Mohr's method was used to identify the total carbohydrates content. Atomic absorption spectrophotometry was used to measure the mineral content, while the vitamin contents (A, B2, B6, D) were obtained by high performance liquid chromatography.

All the analyzes in this study were done in triplicate and only the mean values are included in the statistics

2.5. Statistical Analysis

Results from this study were statistically analyzed with MINITAB 14 software. The methods used are: variation analysis (ANOVA) and the test of comparison of Fisher. The level of significance was set at 5%.

3. Results and Discussion

3.1. Physico-chemical Parameters of Milks

Physico-chemical parameters of raw milk of the both breeds of cows are shown in Table 1. The type of the animal or the system of breeding has no significant effect on the temperature and on the density of the collected milk. The milk of the Girolando breed is less acidic with regard to the pH. This result was confirmed by the highest titratable acidity value obtained in Borgou cow's milk ($p < 0.001$). There is a significant difference ($p < 0.05$) for the dry matter content with a rate of 13.15% for Girolando cow's milk.

Table 1. Physico-chemical characteristics of crude milk from Girolando and Borgou cows

Parameters	Borgou	Girolando
pH	6.18 ± 0.45^{b}	7.32 ± 0.22^{a}
Titratable acidity (°D)	28.65 ± 0.71^{a}	25.09 ± 1.61^{b}
Density	1.04 ± 0.01^{a}	1.05 ± 0.01^{a}
Dry matter content (%)	11.84 ± 0.71^{b}	13.15 ± 1.62^{a}

The density of the milk depends directly on the dry matter content, strongly related to the watering frequency [9]. In this study, density and dry matter content for the same sample have a similar trend. The results of the density and dry matter content of the two types of milks are close to those obtained by [8]. Other works on dry matter milks high producing cows (Montbéliarde and Holstein) are similar to the present results: 11,75% in Morocco [10], 10,48% in Tunisia [11]. The variation in total dry matter content is thought to be due to various factors such as the quality of the water and the quantity available for the animals [12]. Yagil and Etzion (1980) [13] showed that switching from a hydrated diet to a low water diet dramatically reduced the total dry matter level from 14.3 to 8.8%. The dry matter content of milk also varies according to several factors: lactation stage, seasonal factors, environment, lactation rank, number of calving [12].

The titratable acidity obtained in this study presents a significant difference ($p<0.001$) with a higher value for the milk of the Borgou breed (28.65 ± 0.71°D). Titratable acidity is a test indicating raw milk quality and provides an indirect measure of the acid content in milk. Milk acid content could increase by the bacteria that convert lactose to lactic acid. When this occurs, a dramatic increase in titratable acidity value is observed [14]. According to [15] the titratable acidity of raw milk is 18°D. The two milks could therefore contain a high level of bacteria. In this case, hygienic conditions during milking and the chain of conservation of these milks must be reviewed to avoid inconvenience after their consumption.

The pH is higher for Girolando milk unlike that of Borgou. The Borgou's pH value is similar to that of some authors such as [9,16,17] who reported respectively a pH of 6.62 ± 0.13; 6.37 ± 0.06 and 6.31 ± 0.15 for cow milk. The pH value of Girolando milk is around 7.2, which is closer to human (7.3) and mare milk (7.18) [18]. The pH value of the two varieties of raw milk, were very close to that of the standard (6.6 - 6.8) and their titratable acidity values and pH values must show an opposite trend [19]. In view of the pH values, these milks can be consumed by both adults and children.

3.2. Nutritional Properties of Milks

Nutritional properties of the two milks have been dispatched into two categories: macronutrient and micronutrient. Table 2 show the macronutrients content of the both milks. There is no significant difference between: fat, total carbohydrates and proteins content of the two cow's milk.

Table 2. Macronutrients contained in crude milk of Girolando and Borgou cows

Parameters	Borgou	Girolando
Fat content (g/100gDM)	4.06±0.21[a]	4.17±0.27[a]
Total carbohydrates (g/100gDM)	29.36±0.71[a]	28.85±0.74[a]
Proteins content (g /100gDM)	4.26±0.53[a]	4.46±0.68[a]

Proteins and fat content of the two milks, were in accordance with the standard NS 03-020 [20] which indicates 24 à 55 g/l for fat content and 29 à 50 g/l for proteins content. Both milks were therefore rich in fat and proteins.

The fat content obtained in the present study is higher than that obtained by [8] (3.59 ± 0.100 and 3.68 ± 0.010%) which worked on the milks of the two breeds of cow. Fat in milk depend on the breed, the season, the feeding and watering conditions, the lactation period, the number of milking and the milking time [21,22]. As for carbohydrates and proteins, Vaitchafa and *al.*, (1996) [23] in their work on the Holstein breed (a breed High Producer Dairy) reported that this breed produces a significant amount of milk with a low carbohydrate, lipid and protein content. This difference was not observed in this study. This could be justified by the fact that Girolando breed comes from the cross between the Holstein breed and the Gir breed. While milk elements have good heritability; it is 0.5 and 0.6 respectively for proteins and fats [24].

Table 3 presents minerals and vitamins contents (macronutrients) of the milk. With the exception of magnesium content ($p>0,05$), the determination of minerals reveals significant differences between the levels of Calcium, Phosphorus, Potassium and Sodium ($p<0,001$), with a high content sodium in the milk of the Girolando cow. The frequency of breeding has low influence on the content in minerals of crude milk of cow, sole breeding has shown absence or low influence of the content in phosphorus (from 5 to 7%) [25].

Minerals are very important to human body growth and development of their skeletal structure. Magnesium is one of the ten essential minerals with an RDA of 400 mg/day for healthy adult males and 320 mg/day for healthy adult females. For a better mineral supply, Borgou milk would be the most recommended for children.

Table 3. Micronutrients contained in crude milk of Girolando and Borgou cows

Parameters	Borgou	Girolando
Phosphorus (g/kg)	0.95±0.03[a]	0.80±0.06[b]
Potassium (g/kg)	1.04±0.05[a]	0.66±0.06[b]
Calcium (g/kg)	1.09±0.07[a]	1.01±0.05[b]
Magnesium (g/kg)	0.13±0.01[a]	0.13±0.01[a]
Sodium (g/kg)	0.48±0.04[b]	0.60±0.04[a]
Vitamin B2 (ppm)	405.97±32.57[a]	0.00±0.00[b]
Vitamin B6 (ppm)	0.01±0.00[a]	0.00±0.00[b]
Vitamin A (ppm)	2.81±0.94[a]	1.14±0.11[b]
Vitamin D (ppm)	4993.70±1.91[a]	656.10±4.25[b]

With regard to vitamin levels, a significant difference ($p<0.001$) is observed for all vitamins with higher levels in the milk of Borgou cows. The milk of Girolando cows contains some traces of vitamins B2 and B6 while vitamins A and D are present.

Vitamins are biological substances necessary for life since they contribute as cofactors in the production of enzymes and the exchanges of cells [26]. Human body is not able to produce them. Milk is one of foods that has high varieties of vitamins, all the same, their contents are very often weak [26]. Cow milk is an important source of vitamins, necessary for human, it occurs in the phenomenon of oxidation-reduction [27]. It helps in reducing neurological injuries responsible for some craziness: its deficiency with kids can cause convulsions. It is very sensitive after its exposure to sun milk can take 50 to 80% its contents in vitamins. The presence of Vitamin B in the milk from Borgou cows is an advantage of its consumption. According to [27], drinking two cups of milk per day, even skimmed, is already sufficient to restore the lack of vitamins B12.

4. Conclusion

From this study, we can say that milk from both species have physio-chemical and nutritional significant differences depending on the breeding position and age. Both of the two type of milk could contribute to fight against malnutrition in rural areas but none of them has at the same time significant quantity and quality for human needs. The consumption of milk is an important input for micro and macro nutrients for the body, the results of this research work can serve as guide for nutritionists in the choice of the milk to be consumed depending on the age and the energies provided by individuals to be advised.

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