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Description of the zootechnical performance of the indigenous Algerian cattle breeds "Atlas Brown" from the region of El Ouldja in western Algeria

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Graphical Abstract

Abstract

Animal species, with all their characteristic breeds, are little known, and some are even in the process of extinction, with ecological and economic consequences. The local "Atlas Brown" cattle breed, in particular, represents a vital resource and a universal genetic heritage subject to increasing genetic erosion. This breed is divided into rustic sub-breeds "Cheurfa, Guelmoise, Sétifienne, Chélifienne and Kabyle" which owe their name to the region where they are established. The majority of the farms are managed according to an extensive silvo-pastoral system. The physico-chemical analysis of raw milk in the El Ouldja region (Algeria) is mainly influenced by the three periods of milk production during the year. The milk presented a pH of 6.64, a density of 1.028, a dry matter (DM) of 11.13%, a fat (FM) of 28.50% and a protein (PM) of 26.48%. Due to the high lactose value (Lac) of 47 g/L in the high season, it can be considered that the milk of local cows in the El Ouldja region can be used and valorised in the yoghurt industry. The zootechnical services collected make it possible to anticipate an enrichment of the data in order to perpetuate this bovine species. In addition, the control of physico-chemical data of raw milk from local cows offers new opportunities for the development of local food production.

Keywords: El Ouldja region; indigenous breed; zootechnical performance; physico-chemical parameters; raw milk.

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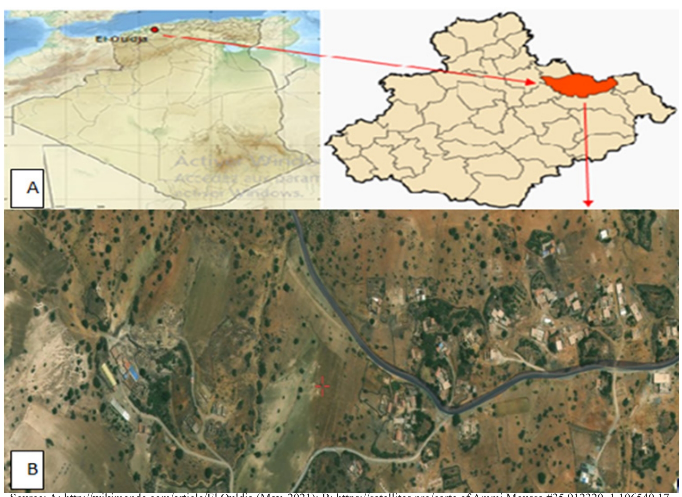
Introduction

The Algerian cattle population, in all its diversity, evokes the wealth of the country and represents a real heritage. Its territorial location is explained by the nature of the soil, the climate and the quality of the pastures. In Algeria, the local breed "Atlas Brown" or Cape Bon Blond of Iberian origin [1], is divided into rustic sub-breeds according to [2]: Cheurfa, Guelmoise, Sétifienne, Chélifienne, and Kabyle which take their name from the region where they live. Its main ancestor would be the Bos mauritanicus discovered by Thomas in the quaternary period in North Africa. The total population was about 1, 404,000 head, of which 764,000 were breeding females and 19,000 breeding males, occupying difficult areas. Almost two thirds of the total population is located in the east of the country [3]. The local herd contributes about one third of the national milk production, or 1000L/year [4]. It is necessary to know the physicochemical composition of the raw milk of local cows in the sampled area in the region of El Ouldja because no study has been conducted in this area and no information is available on its physicochemical composition. This synthesis aims to fill this gap by evaluating the nutritional quality of raw milk according to the rearing practices carried out in three traditional farms in the El Ouldja region (Algeria), rearing exclusively autochthonous cows: Atlas Brown, and to popularise the phenotypic characteristics of this part of the Algerian bovine herd, which serves as a support for the preservation of our genetic resources.

Materials and methods

Presentation of the local breed in Algeria. The study started in September 2019. The cattle concerned are all of the local breed " Atlas Brown ", reared in an extensive system by three breeders in the region of El Ouldja, illustrated in Figure 1, which is a northern locality located 6 km from the commune of Ammi Moussa, 72. 2 km from the chief town of Relizane (Western Algeria) and 55.9 km from the chief town of Chelf (Western Algeria). It is located at 35° 54′ 39″ North and 1° 07′ 15″ East, i.e. 35.9108 latitude and 1.12072 longitude.



Source: A: http://wikimonde.com/article/El Ouldja (May, 2021); B: https://satellites.pro/carte of Ammi Moussa #35.912320, 1.106540,17.

Figure 1. Location and satellite view of the municipality of El Ouldja (Relizane, Algeria).

Source: Local cattle breeds photographed in 2019 in the region of El Ouldja "Algeria".

Figure 2. Indigenous cattle breeds.

The indigenous cattle are medium-sized, with dense coats of different colours (fawn, grey, white, and black), reflecting the heterogeneity of this population in the study area (Figure 2), with an average milk production that varies from farm to farm. Feeding is based on pasture vegetation: *Ampelodesma mauritanica*, *Chamaerops humilis*, *Pistacia lentiscus*, *Juncus arabica*, *Ziziphus lotus*, rangelands, fallows, crop residues, etc.) supplemented by hay, straw and concentrate, sometimes not at all, depending on the farmer's cash flow. Milking is done twice a day and the average amount of milk milked fluctuates according to the season (maximum 3 to 4 litres of milk per cow per day). On the whole, the cows have totalled between 1 and 7 lactations and at different stages (from the 1st to the 10th month). The performance of these cattle is conditioned by the vicissitudes of the forage and the climate.

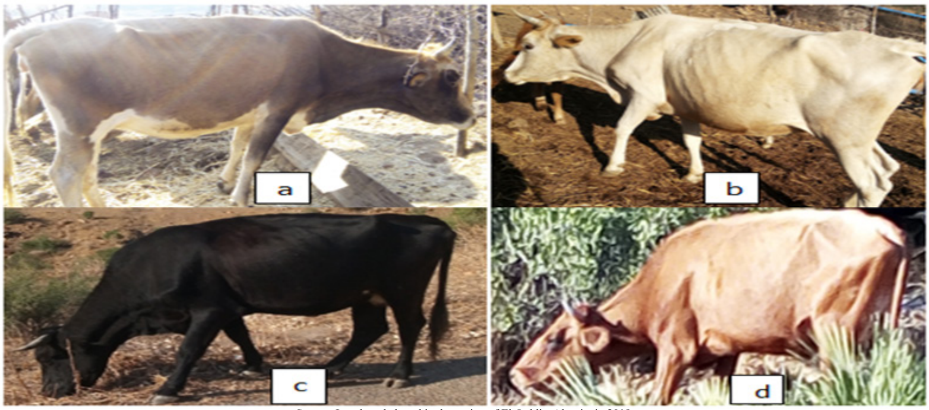
The different populations that make up the Atlas Brown are morphologically distinct. There are:

- The Guelmoise which is dark grey in colour, living in wooded areas [5]. This population is identified in the regions of Guelma and Jijel and constitutes the majority of the national population (Figure 3.a).

- The Cheurfa, a group of cattle with an almost white grey coat, is located at the edge of the woods in the regions of Jijel and Guelma (Figure 3.b).

- The Sétifienne, with its uniform blackish coat (Figure 3.c), is of good conformation, varying in weight and size depending on the region where it lives. Its long black tail drags on the ground. This type of cattle is characterised by a brown line on the back. The weight of the females is close to that of imported females, which are generally raised semi-extensively in the high cereal plains. Milk production can reach 1500 kg/year.

- The Chelifienne is fawn-coloured with a long black tail that drapes the ground. Its head is short, with hooked horns, and prominent eye sockets surrounded by dark brown spectacles (Figure 3.d).



Source: Local cattle breed in the region of El Ouldja, Algeria, in 2019.

Figure 3. The different component species of the "Atlas Brown" breed.

Sampling procedure. A total of nine milk collections are made over the three dairy seasons of the 2019/2020 period. The cows are milked manually in the morning. Milk is collected directly from the cow's udder. The samples are then transported in a refrigerated cooler (4°C) and kept at this temperature for a maximum of 12 hours before being analysed. Samples are taken simultaneously from three farms in the region. Sampling is scheduled according to the milk production season: Medium, Low and High. The samples are submitted to the laboratory for physico-chemical analysis according to the IDF standard [6].

Temperature. Immediately after milking, the temperature of the milk is measured with a thermometer.

pH. As soon as milking is completed, the hydrogen potential is measured using pH indicator strips. It is measured again on arrival at the laboratory using an Orion Reseach pH meter (PHSU-3F) after calibration at pH 7.02 and 4.00 by dipping it into a small cubage of milk taken from a beaker.

Density. It is measured with a thermo-lactodensimeter (Gerber Standard 081.006610.00) containing a thermometer and a correction grid, and graduated in 0.0005 calibrated units in relation to water. It is brought back to 20°C by the following formula:

Corrected density = density read + 0.2 (milk temperature ± 20°C).

Freezing point. This is determined using a LACTOSCAN Ultra Sonic (Series No. 16/68). The control of this parameter makes it possible to evaluate the quantity of water that can be added to the milk, a wetting of 1% thus translates into an increase of approximately 0.0055°C.

Mineral content. This is determined using a LACTOSCAN Ultra Sonic (Series No. 16/68). Minerals in food have both nutritional and functional uses. Phosphorus, for example, is needed to retain water and modify the texture of processed cheese. Calcium contributes to the gelling of proteins and gums.

Water and dry matter content. The dry matter content is assessed first by evaporation in a water bath at 70°C and then by drying the sample (ml/g) for 3 hours in an oven (Memmert UF30) at 103 ± 2°C.

Fat content. The Gerber acid-butyrometric method is applied using the Gerber A Milk Butyrometer 0-6% MG 249780. This method involves attacking the sample to be tested with sulphuric acid and recovering the fat released by centrifugation in the presence of isoamyl alcohol.

Protein content. This is determined by the Kjeldahl method using a Kjeldatherm KT M040649. This method involves the mineralisation of the sample (milk) by heating in the presence of a mixture of concentrated sulphuric acid, potassium sulphate and copper sulphate, to convert the organic nitrogen in the sample to ammonium sulphate. Soda is then added to the reaction product to release ammonia, which is titrated with a hydrochloric acid solution in the presence of boric acid. This allows the total nitrogen in the milk to be measured by the formal Kjeldahl method and then multiplied by a factor of 6.38 to obtain the protein content of the milk or cheese.

Lactose content. This is determined using a DR 3900 bench-top spectrophotometer. To 1 ml of milk is added 1 ml of phenolated water and 5 ml of sulphuric acid and the whole is homogenised mechanically on a vortex (Cadillac) and then boiled for five minutes.The absorbance is read at 490 nm against a control prepared with distilled water. A standard curve is made from a stock solution containing 1 g/L of lactose.

Results and Discussion

Temperature. The temperature of the milk, measured immediately after milking, varies between 26 and 28°C. The lowest temperature is observed during the middle season 26°C and the other two milk seasons show the same value 28°C (Table 1). This difference can be attributed either to the volume of milk at the time of the temperature measurement or to the time between milking and the measurement.

pH. The pH obtained is on average 6.64 ± 0.04. It is lower in the high season 6.58 and slightly higher in the low season to 6.72 (Table 1). Freshly milked cow's milk has a pH between 6.60 and 6.80. According to [7], the pH of milk is an indicator of the health of the animal and the hygiene of the milking process. Indeed, differences in pH between milk production seasons are related to milking hygiene, as described in [8], to the health status of the animal and to microbial infections [9]. During a mammary infection, there is a high call of leukocytes, which leads to an increase in the number of cells, inducing a degradation of casein and lactose and thus a decrease in pH. Our results are similar to those described by [10] and superior to those obtained by [11].

Density. The density of the milk measured at 20°C shows an average of 1.028 according to table 1. This value is lower than the AFNOR standards 1.030-1.032. Nevertheless, and according to [12], the density of the samples of the high season 1.029 is consistent. The values thus obtained are similar to those reported by [13]. The study by [14] showed that milk density varies with DM content in general and fat content in particular.

[15], However, states that the higher the fat content of milk, the higher and more significant the density of milk. That is, the density decreases when the milk is wet, which is not the case in this study since the samples are taken directly from the udder. The low density of our milk could be due to the low DM and fat content, the climate change of this year 2019/2020 and the feeding. The same phenomenon was observed by [16].

Freezing point. The highest values are observed during the low season (-0.508°C) and the lowest are obtained during the high season (-0.528°C). These results lead us to consider that the variations in freezing point are due to variations in milk production and refrigeration, as pointed out by [17]. Similar results to our observations are reported by [18]. In principle, the freezing point of milk is between (-0.520°C) and (-0.525°C). It is not excluded that the milk of a herd has a freezing point below (-0.525°C) due to various causes, in this case, the influence of feeding in the warm season, often due to a lack of energy and fibre, the stage of lactation, heat stress from 24°C onwards, poor fermentation in the rumen and reduced feed intake. The lower freezing point of water (1) results from the elements dissolved in the milk. These are lactose, salts and minerals. The higher the concentration, the lower the freezing point.

Mineral content. The mineral content of the milk is similar for the medium and high season 4.6 g/L against 3.9 g/L for the low milk season (Table 1). These values are much lower than the one found by [19] which is 7.8 g/L. It is certain that the capital of Jijel is one of the most irrigated regions of Algeria, thus ensuring important water resources. This abundance of precipitation gives the region a mountainous arboriculture, thus favouring cattle breeding. It has been published by [20] that the mineral content of milk is relatively related to the nature and quantity of grass grazed per animal. If the feed ration in P and Ca is insufficient, the animal depletes its bone reserves to compensate for the lack. However, in case of severe deficiency, milk production and quality systematically decrease.

Water content. The water content varied from 88.4 to 89.2 g/L with an average of 88.86±0.24 for the three seasons tested (Table 1). Our results are similar to those obtained by [19] which are 89 g/L in the local cow in eastern Algeria but much higher than those of the Pia red breed 85.81 g/L in the same region. Milk is a colloidal suspension of PM in serum containing mainly lactose and sodium. These two elements condition the flow of water from the cells to the lumen of the secretory acini as they have an osmotic activity and therefore act on the level of milk produced.

Dry matter content. It varies between 108 and 116 g/L respectively for the low and high season (Table 1). The authors [21] noted that the amount of DM ingested is positively proportional to the dry matter content of the plant and that the consumption time decreases with dehydrated grass. The resulting DM values are reduced with the unusual climate change of this year 2019/2020, resulting in dry forage due to lack of rain. Some studies also report a decrease in the proportion of DM and PM in milk with an increase in the temperature-humidity index “THI” [22]. Heat stress decreases DM consumption, which in turn decreases energy consumption and thus the content of milk components. Our results are close to the range of 113 to 115 g/L obtained by [23].

Fat content. The high season stands out with a fat content of 32 g/L, while the other two seasons have an almost identical value of 27 g/L. The average fat content of 28.50±1.75 g/L is lower than the Algerian standards of 34 g/L and the average of 36.70 g/L reported by [19]. The fat content varies according to the season, the feed, the breed, the stage of lactation [24] and the production level. Indeed, the feed ration determines the proportions of volatile fatty acids during ruminal fermentation, which are important precursors of mammary lipogenesis. Furthermore, cow performance is a product of genotypic potential and rearing conditions.

Protein content. The protein value of the milk is similar for the seasons: medium and low 25.80 g/L ($p>0.5$). However, the high season has the highest content 27.80 g/L. This value is in line with that found by [20] for the same breed which averages 27.90 g/L but well below the standard quoted by [25] which is 33 g/L and the value obtained by [26] which is 30 g/L from raw milk of modern breed cows. Protein intake obviously varies according to the stage of lactation, genetic factors, health status of the animal and climatic conditions. Obviously, the proportion of casein decreases systematically as the stage of lactation advances. Mastitis, lameness, acidosis, parasitic infestations and placental retention are among the most feared effects on milk production. The results obtained and those from eastern Algeria lead us to conclude that the milk of local Algerian cows has a low protein content and that its use in the cheese industry is questionable.

Lactose. According to the results in Table 1, the high season has the highest value 47 g/L and the low season the lowest value 40.5 g/L with an average of 44.66%. Our results are within the range of 40-50 g/L proposed by [16] for raw milk and are higher than those of the milks studied by [27] and [11] which have an average of 42.16 g/L and 35.90 g/L respectively. It is likely that breed has an impact on lactose levels as reported by [28]. Lactic acid bacteria ferment lactose into lactic acid. In the present study, samples are analysed 12 hours after milking, which would have led to the development of lactic acid bacteria, resulting in a low lactose content compared to the reference value of 48 - 49 g/L [26]. Nevertheless, the high value of 47 g/L in high season suggests that the milk of local cows in the El Ouldja region can be exploited and valorised in the yoghurt industry.

According to [29] and [30], milk from breeds with low milk production potential in Mediterranean and tropical areas is generally more concentrated in fat, DM and protein. However, the results of our samples give the opposite impression of this observation. Indeed, [31] agree that milk production also depends on intrinsic factors related to the animal and extrinsic factors related to its environment.

Table 1. Physico-chemical characteristics of the milks used (g/L).

Parameters	Medium season	Low season	High season	Average	Standard error
T (°C)	26	28	28	27.33	0.66
pH	6.64	6.72	6.58	6.64	0.04
Dst	1.028	1.027	1.029	26.48	0.65
FP (°C)	-0.514	-0.508	-0.528	44.66	2.08
M.M	4.64	3.9	4.6	28.50	1.75
Water	89	89.2	88.4	1.028	0.0005
DM	110	108	116	-0.516	0.005
FM	26.5	27	32	88.86	0.24
PM	25.85	25.8	27.8	4.38	0.24
Lct	46.5	40.5	47	111.33	2.40

T: Temperature; Dst: Density; F.P: Freezing point; M.M: Mineral matter; D.M: Dry matter; F.M: Fat; P.M: Protein; Lct: Lactose

Conclusion

The physico-chemical evaluation of raw milk measured in this study allowed a better understanding of the characteristics of the batches produced according to the dairy season. It was found that the fat, protein, and lactose concentration of raw milk is very low in the low season. Thus, the protein concentration is 25.80 g/L in the low season against 27.80 g/L in the high season, and the fat concentration is 27 g/L in the low season against 32 g/L in the high season. The lactose is 40.50 g/L in the low season compared to 47 g/L in the high season, and the dry matter is 108 g/L in the high season compared to 116 g/L in the low season. It appears that the milk of local cows in the El Ouldja region has a low protein content, and its use in the cheese industry is therefore questionable. However, the high lactose content of the milk, 47 g/L, allows its use in the yoghurt industry. The concentration of nutritional parameters in the raw milk of local cows varies according to herd management, geographical location, climatic conditions, feed quality and availability.

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

All authors have read and agreed to the final version of the manuscript.

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