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CHARACTERIZATION OF FRESH CAMEL MILK, OPTIMIZATION OF PRODUCTION AND DETERMINATION OF THE QUALITY OF YOGHURT OBTAINED BY THE EXTRACT OF BALANITES AEGYPTIACA FRUITS

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ABSTRACT

The transformation of milk into yogurt requires the use of lactic ferments. Given the high cost of these products, the difficulties related to their preservation and their accessibility, the need to replace them with others that are less expensive, more accessible and easy to preserve is essential. This study aims to transform camel milk into yogurt using natural coagulants of vegetable origin such as extracts of Balanites aegyptiaca fruits. The physicochemical, microbiological and organoleptic characteristics of yogurts prepared using these extracts were determined using standardized methods.

(AFNOR, Codex Alimentarius).

The physico-chemical and organoleptic parameters show that the yoghurt obtained with the fruits of Balanites aegyptiaca is comparable to the yoghurt with lactic ferments. The evaluation of the coagulant properties of extracts of plant origin such as the fruits of Balanites aegyptiaca made it possible to optimize the conditions of extraction of extracts of plant origin and the conditions of coagulation of camel milk by these extracts. This study showed that the proteases from Balanites aegyptiaca pulp extracts are able to replace lactic ferments for yoghurt.

This result is promising, especially since the availability and cost of these plant extracts are within reach of camel breeders and easy to obtain.

Keywords: Camel Milk, Yoghurt, Extracts, Balanites Aegyptiaca .

1. INTRODUCTION

Mali is an agro-pastoral country. Livestock occupies a very important place in the country's economy, it ranks 3rd among exported products after cotton and gold (DNPIA 2021). The number of national livestock in 2021 was estimated at 12,848,696 cattle, 21,149,809 sheep, 29,201,079 goats, 607,786 horses, 1,190,567 donkeys, 1,291,233 camels, 88,262 pigs and 54,703,373 cattle. of poultry (DNPIA 2021).

Cow and camel milk constitute the largest volume of the national dairy potential. It should be noted that the regions of Kidal, Gao, Mopti and Timbuktu are potential milk production regions.

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Potential milk production is largely made up of bovine milk. It is important to point out that this estimate leaves very little room for the current situation of milk production in the peri-urban environment in general and that of Bamako and Koulikoro in particular where the milk production of second-generation mixed race women is estimated between 20 and 25 liters per day per cow (DNPIA 2021).

Milk occupies an important place in the food intake of the world population. Indeed, this product, irreplaceable for infants, is also vital for other age groups, due to its high intake of basic nutrients (proteins, lipids and carbohydrates) and its richness in mineral elements, in particular calcium and in vitamins (FAO 2011). Camel milk is appreciated by nomadic shepherds (Moors, Tuaregs, Peulhs, Toubou, Arabs) who find it has therapeutic virtues. It is eaten raw, fermented, pasteurized, sterilized or transformed into cheese, and provides nearly 50% of the diet of pastoral communities (OUOLOGUEM, MOUSSA et al. 2017). The valorization of camel milk is an excellent development opportunity for the inhabitants of arid zones. Indeed, the daily sale of milk brings a regular monetary income to breeders, without affecting their capital and without significantly modifying their way of life (OUOLOGUEM, MOUSSA et al. 2008).

It is to further enhance that this study aims to optimize the production and determine the quality of yogurt obtained by extracting the fruits of Balanites aegyptiaca from camel milk.

2. MATERIAL AND METHODS

2.1 Site or place of study

The study was conducted at the Sotuba Food Technology and Cattle Program Laboratory

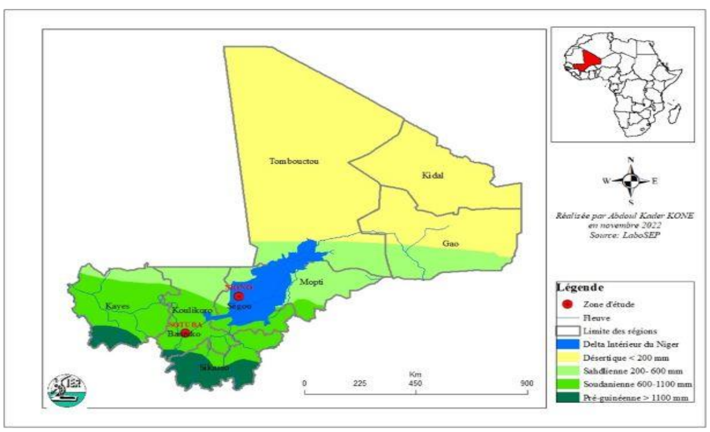

Figure 1: Map of the location of the study sites

Material

- Biological material: camel milk; powdered milk
- Plant material: balanitis fruits
- Technical equipment: thermos, a ladle, stainless steel pots; gas stoves, thermometer, pH meter, fine-mesh sieve.

Methods

❖ **Characterization of fresh camel milk**

➢ **Physico-chemical characterization of fresh camel milk**

- **pH determination**

The pH is measured using a "HANNA instruments" brand pH meter. Before each measurement, the electrode of the pH meter is cleaned with tap water, then rinsed with distilled water and dried with blotting paper. A check on the reliability of the pH meter is carried out before each measurement, by calibrating the device using two buffer solutions of known pH (4.00 and 7.00). Then the measurement is made by immersing the end of the electrode in the milk. The pH value is immediately displayed on the screen. Before undertaking another measurement, the electrode is cleaned again, then rinsed as before.

- **Determination of water content and dry matter**

These parameters were measured using a device called the moisture meter. Five samples of 1 g each were placed in the moisture meter set at a temperature of 160°C. The dehydration process continues until the automatic shutdown of the device. Thus, the water content and dry matter values are read directly on the device.

- **Determination of ash content by the dry method**

We took 10 ml of camel milk in 5 porcelain crucibles whose empty weights were determined (M0). Then place them in the crucible furnace + milk ((M1) using tongs for 2 hours at a temperature of 500° C (until the ash is obtained, which is light gray in color). After , cooling of the crucibles in the desiccator overnight, the crucibles are weighed again and their contents were weighed to determine the weight after desiccation (M2).
To calculate the ash content, the following formula is used:

$$\% \text{ Cendre} = \frac{M2 - M0}{M1 - M0} * 100 * \left(\frac{100}{100 - H}\right)$$

M0: Weight of the Empty Crucible; M1: Weight of the crucible and the sample before incineration in grams; M2: Weight of the crucible and the sample after incineration in grams; H: Humidity.

- **Fat determination**

The fat content was determined following the instructions of AFNOR (1993). Thus a solution of 10 ml of H_2SO_4 at 96% was introduced into test tubes. Then 11 ml of each sample and 2.5 ml of isoamyl alcohol were added. The mixture was then centrifuged at 36,000 rpm using a centrifuge. The fat content was determined by measuring the supernatant (fat) heights using a graduated ruler.

- **Determination of proteins by the Kjeldahl method**

In a Kjeldahl matrass are introduced 1g of the sample, a pellet of Kjeltabs catalyst and 10 ml of concentrated sulfuric acid. The mixture is subjected to mineralization for 4 hours at 400°C until a completely discolored solution is obtained. After cooling, 50 ml of distilled water are added to the mineralizate, which is then neutralized with a 40% sodium hydroxide solution. The mineral is then cooled and its volume is made up to 50 ml with distilled water before being neutralized with a 40% NaOH solution. The neutralized solution is distilled and the ammonia solution collected in an Erlenmeyer flask. The distillation is stopped when the final volume in the Erlenmeyer flask reaches 150 m.

- **Expression of results**

The percentage of protein results contained in a sample after pepsin treatment shows indigestible protein.

$$\%\text{N non Digestibles} = \frac{(V - V0) * N * 14{,}08 * 100}{0{,}200 * 1000}$$

% Digestible Protein = % Digestible N x 6.25;
V = volume of acid used for the titration of the sample;
V0 = volume of acid used for the titration of the blank;
6.25 = is the nitrogen to protein conversion factor.

- **Characterization of the enzymatic extract**
- **Determination of clotting time**

The coagulation time is determined by the Berridge method by incubating 10 ml of fresh camel milk in a test tube immersed in a water bath at 30°C and 1 ml of coagulant extract of B. aegyptiaca fruits or 1 ml of rennet. The test tube is subjected to a slow rotational movement. The time that elapses between the introduction of the coagulant extract and the moment when a thin film begins to form inside the walls of the test tube is measured.

- **Determination of the optimal pH**

The pH has a strong influence on the enzymatic activity of these preparations and consequently on the coagulation time of the milk (Ramet 1997). In order to find the best conditions for enzymatic activities, we examined the effect of the following pH values: 5.8; 6; 6.3 and 6.6 on the activity produced. The experiment is carried out en bloc. For this, three blocks representing the three repetitions are made. It each includes four experimental units of camel milk under the same conditions of temperature and $CaCl_2$ concentration but differing in the pH value adopted and the nature of each coagulant extract.

- **Determination of the optimum temperature**

The temperature of camel milk is adjusted to values of 50; 45, 40 and 30°C. The coagulation times are then measured for each temperature and for each coagulating extract the average of three repetitions (not far apart) makes it possible to obtain a coagulation time for each temperature and for each preparation of coagulant extract.

- **Preparation of Balanites aegyptiaca fruit extracts**

The extraction of balanitis fruit extracts was carried out using the following protocol: Three extract preparation trials (200g, 150g, 100g) in three repetitions in 100 ml of hot water at a temperature of 100°C for 40 mins. The extracts obtained were cooled and filtered with a pH of 5.28±0.013. After extraction, the extracts are stored in the refrigerator at 8°C. The best concentration is obtained with the test of 200g of balanitis fruits in 100ml of water.

- **Determination of the organoleptic quality of camel milk yoghurt**

The acceptability of the yogurt samples was assessed by a jury of 12 tasters, made up of students, laboratory technicians and researchers with considerable knowledge of organoleptic quality.

- **Statistical analysis**

Each test was repeated three times and the results obtained were expressed in terms of descriptive statistics (frequency of citation, means, standard deviation, etc.).

3. RESULTS

Characterization of fresh camel milk

Physico-chemical analysis of fresh camel milk

Table No 2 gathers the results relating to the Physico-Chemical characteristics of 5 samples of camel milk.

Table 1: Physico-Chemical parameters of fresh camel milk

Samples	M. Sèche (g/l)	Humidity (%)	Protein (g/l)	M. Grasse (g/l)	Ash (g/l)	pH
Fresh milk 1	128,2	87,15	34,47	29	0,68	6,4
Fresh milk 2	118,3	88,17	35,34	28	0,58	6,5
Fresh milk 3	128,1	87,18	35,46	29	0,69	6,3
Fresh milk 4	118,6	88,14	35,44	28	0,67	6,4
Fresh milk 5	113,6	88,63	33,89	28	0,5	6,3
Average	**121,36**	**87,45**	**34,92**	**28,4**	**0,62**	**6,38**
Cow-control milk	**127**	**80,73**	**31,51**	**34,52**	**1,13**	**6,6**

Preparation of camel milk yogurt using Balanites aegyptiaca fruit extract

For 1 liter of dromedary milk, 40g of powdered milk (for consistency) was added then mix well with a ladle then filtered. The mixture was heated at 80°C for 5 minutes and cooled at different temperatures then inoculated with different doses of extracts of Balanites aegyptiaca.

Table 2: Parameters of yogurt with Balanites aegyptiaca fruit extract

Quantity of milk (ml)	Extract quantity (ml)	Incubation temperature °C	Clotting time (hour)	pH
1000	30	45	10	4,1
1000	25	45	12	4,4
1000	20	45	16	4 ,6
1000	15	30	24	4,8
Control cow's milk	Lactic ferments	45	3	4,6

Determination of the physico-chemical characteristics of yoghurt with camel milk
The results relating to the physico-chemical characteristics of yogurt with the extract of the fruits of Balanites aegyptiaca

Table 3: Physico-chemical parameters of yogurt

Samples	M. Sèche (%)	Humidity (%)	M. Grasse (g/l)	Ash (g/l)	pH
Camel milk yogurt	**26,52**	**73,47**	**4**	**1,22**	**4 ,5**
Cow's milk yogurt	**22**	**75**	**4**	**2,8**	**4,6**

Microbiological characteristics of yogurt

Yogurt samples were subjected to microbiological analysis for the detection and counting of total and faecal coliforms, Escherichia coli and Salmonella. The results are expressed in CFU/ml. CFU (Colony Forming Unit) is a unit used to estimate the number of viable bacteria or fungal cells in a given sample. These results show that the yogurt samples are free of pathogenic microbes so they are of good quality and the parameters comply with the DEHOVE standard.

Table 4: Result of the microbiological analysis of yogurt

Microbiological parameters	Yoghurt	DEHOVE standards
Aerobic total coliforms CFU/ml	0	**10**
Thermo tolerant coliforms CFU/ml	0	**0**
Esehricia coli	0	**0**
Salmonella /Shigella UFC/ml	0	**Absence in 25g**
Technique used	Culture	

Microbiological characteristics of yogurt

Yogurt samples were subjected to microbiological analysis for the detection and counting of total and faecal coliforms, Escherichia coli and Salmonella. The results are expressed in CFU/ml. CFU (Colony Forming Unit) is a unit used to estimate the number of viable bacteria or fungal cells in a given sample. These results show that the yogurt samples are free of pathogenic microbes so they are of good quality and the parameters comply with the DEHOVE standard.

Table 4: Result of the microbiological analysis of yogurt

Characteristics	Yoghurt (30ml)	Yoghurt (25 ml)	Yoghurt (20 ml)	Yoghurt (15 ml)
	Average			
Taste	3	4	5	3
Colour	4	3	4	3
Smell/Aroma	3	3	4	3
Texture	3	4	5	3
General acceptability	**3**	**4**	**5**	**3**

5 = Very good; 4= Good; 3= Fair; 2 = Bad; 1 = Very bad

4. DISCUSSION

The average pH value of the camel milk collected is equal to 6.38±0.083. The camel milk would be slightly more acidic than the analyzed cow's milk (control milk) which has a pH of 6.60±0.013. The pH values of camel milk noted in the present study are close to those reported by certain authors such as (Siboukeur 2007) and (CHETHOUNA 2011) for respective values of 6.31 and 6.37. Other authors put forward higher values, such as (Kihal, Chekroun et al. 1999) with a value of 6.57 and (Boudjenah-Haroun, Laleye et al. 2012) for a value of 6.53. This pH characteristic is due to the relatively high content of vitamin C in camel milk, which is thought to be the cause of the low pH (Saley 1993). The particularity that gives it a particular taste that can be masked by a bitter or acid flavor depending on the nature of the plants grazed. According to (Gorban and Izzeldin 1997), the pH and taste of milk can be affected by feeding and water availability and the stage of lactation and udder health. According to Carole and Vignola (2002) the pH would also depend on the presence of caseins and phosphoric anions. Camel milk is characterized by a higher buffering effect compared to bovine milk (Abutarboush, Al-dagaL et al. 1998)

The total dry matter content of the raw milk samples analyzed is equal to 121.36 g/l±6.5 (Table 11). This seems lower compared to that of bovine milk (128 g/l according to (Alais 1984) and human (129 g/l) (Siboukeur 2007). Ramet (1993) indicated that one of the main characteristics of camel milk is in fact, its dry matter content reduced compared to that of milk from other species. This content also varies according to the stage of lactation (Bengoumi, Faye et al. 1994). According to Ramet (1989) this difference is more marked in the hot season, when the animals are under water stress which increases the water content of the milk.Similarly, (Yagil and Etzion 1980) have noted that the transition from a hydrated diet to a low-water diet causes a drop in the total dry matter rate from 14.3 to 8.8%.The dry matter content of milk also varies according to the stage of lactation (Bengoumi, Faye et al. 1994).Thus, the rate decreases during the months after calving, then increases with increased fat and nitrogen (FAO 1998)

The average fat content of raw milk analysis is equal to 28.4g/l±0.54. It seems slightly lower than that of cow's milk (control milk) (34.52 g/l) and human (45 g/l). It is comparable to that reported by (Mehaïa, Hablas et al. 1995) for the Hamra breed (28.5 g/l) and that reported by (Siboukeur 2007) for the Sahraoui breed (28g/l ±6). It is established that apart from the breed, the milking rank influences the fat content. Indeed, the morning milking gives a milk relatively low in fat in comparison with that of the other milkings, although quantitatively more important (Kamoun 1994). The fat of camel milk contains essential fatty acids such as linolenic acid, unlike that of cow's milk in which unsaturated short-chain fatty acids predominate (Siboukeur 2007).

The average water content value of camel milk is 87.85%±0.65 higher than that of cow 80.73%. This value is either similar, higher or lower than the values obtained from camel milk from other geographical areas (Benguettaia and Lemlem 2013). The water content is a function of the water intake in the diet.

The average protein content is 34.92 g / l ± 0.70 is within the range of works cited by (Mohamed, Mursal et al. 1989) and (Gnan, Mohamed et al. 1994) namely 46g / l and 21.5 g/l respectively. It is lower than that reported by (Siboukeur 2007) 35.68 g/l ±5.64. The protein content varies according to the stages of lactation. According to (Kamoun 1994) the first two months of lactation are characterized by a decrease in the protein and butter content of camel milk. The latter reach a minimum value coinciding with the peak of lactation, then return, at the end of lactation, to a level comparable to that at the start.

The dromedary milks analyzed give a value of the order of 0.62g/l±0.082 which is comparable to that obtained by (Konuspayeva, B.Faye et al. 2009). According to Yagil (1985) the ash content of camel milk varies to a large extent according to dietary intake. It is lower in the milk of dehydrated animals. This variation seems consecutive to the quantities of milk produced (El-amin. and Wilcox 1992) and to the stage of lactation (Farah 1993). This test showed that a coagulating agent can form the gel from the meso

5. CONCLUSION

It is important to point out at this level that despite the poverty of the food it receives, the dromedary produces very rich milk, with a high vitamin C rate, estimated on average at 43.87g/l ±3.10 . This milk is also characterized by a significant protein intake (around 38.5%).

Thanks to these first manufacturing trials, we have noticed that camel milk can be transformed into yogurt using Balanites aegyptiaca fruit extract as a coagulant. Camel milk is an invaluable food resource for the populations of the arid and semi-arid regions of our country, because it is a product relatively rich in nutrients and which also has a natural disposition to conservation superior to that of all milks of other species.

These results are promising, especially since these extracts are available at any time and anywhere on the territory and the cost is derisory. However, it is necessary to carry out more indepth analyzes on the physicochemical characteristics of these coagulant extracts before foreseeing a large-scale use in the short and medium term.

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