

## Milk and Dairy Products Production in Benin

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### ABSTRACT

The recovery strategy for agricultural sector, which gives priority to the value chain approach, renewed interest in both milk production and processing within the framework of livestock development policy. The consumption of locally produced cow's milk has grown considerably in recent decades, despite the fact that Benin isn't a major producer of cattle. The role of milk and milk products in the diet and economy of pastoral communities is well established. However, milk production is still weak and depends on genetic and many other factors. That's is the reason why, despite its economic and nutritional importance, the Beninese dairy industry is still artisanal. Dairy industry in Benin ensures the marketing of derived products like a local cheese "Wagashi" and a local beverage "Degue": two derivative products helping to meet the nutritional needs of the population. The production conditions as well as the lack of standardization of the processing and preservation practices are, among other things, critical points justifying the risks associated with the consumption of derived dairy products in Benin. The decline in quantity of domestic imports of milk and milk products in recent decades has led to a segmentation of the dairy markets where local products play an important role. Hence, the need to evaluate the potential of milk production as well as the risks related to the consumption of this with a view to an industrial valorisation involving consumer health safety. The importance of milk and dairy products in the diet, the cattle breeds involved in milk production and their performance and the risks linked to the consumption of dairy products produced in Benin are discussed in this review.

**Keywords:** Benin, Traditional products, Milk products, Health safety

### Benin'de Süt ve Süt Ürünleri Üretimi

#### ÖZ

Değer zinciri yaklaşımına öncelik veren tarım sektöründeki iyileştirme stratejisi, hayvancılığı geliştirme politikası çerçevesinde hem süt üretimine hem de işlenmesine olan ilginin yeniden canlandırılmasına yol açmıştır. Benin büyük bir sığır yetiştiricisi olmamasına rağmen yerel olarak üretilen inek sütünün tüketimi son yıllarda önemli ölçüde artmıştır. Süt ve süt ürünlerinin pastoral toplulukların diyet ve ekonomisindeki rolü iyi bilinmektedir. Bununla birlikte, ülkede süt üretimi hala düşüktür ve genetik veya birçok diğer faktöre bağlıdır. Benin süt endüstrisinin ekonomik ve besleyici önemine rağmen hala zanaatkâr olmasının nedeni ise budur. Benin'deki süt endüstrisi, toplumun besinsel ihtiyaçlarının karşılanmasına yardımcı olan; yerel bir peynir olan "Wagashi" ve yerel bir içecek olan "Degue" gibi ürünlerin pazarlanmasını sağlamaktadır. Diğer unsurların yanı sıra, üretim koşulları ile işleme ve muhafaza uygulamalarındaki standardizasyon eksikliği, Benin'de üretilen süt ürünlerinin tüketiminden kaynaklanan riskleri haklı kılan kritik noktalar. Benin'de son yıllarda ithal edilen süt ve süt ürünlerinin miktarındaki düşüş, yerel ürünlerin önemli bir rol oynadığı süt ürünleri piyasasının bölünmesine yol açmıştır; bu nedenle süt üretim potansiyeli ile tüketimden kaynaklanan risklerin, tüketicinin sağlık güvenliğine odaklanmış bir sanayileşme açısından değerlendirilmesi gerekmektedir. Bu derlemede, Benin'deki süt ve süt ürünlerinin diyetteki önemi, süt üretimine katılan hayvan ırkları ve performansları ile Benin'de üretilen süt ürünlerinin tüketimine ilişkin riskler tartışılmıştır.

**Anahtar Kelimeler:** Benin, Geleneksel ürünler, Süt ürünleri, Sağlık güvenliği

## INTRODUCTION

Like most West African countries, Benin's economy is mainly based on agricultural production. In 2012, agriculture contributed to 32.7% Gross Domestic Product (GDP), of which 2.4% is related to livestock [1]. Livestock farming plays an important role in Benin's agricultural sector. This activity is part of 13 sectors of the Strategic Plan for Agricultural Sector Recovery (PSRSA) adopted by the government of Benin in 2011. This plan reflects not only the strategic orientations for development and poverty reduction but also aims to meet some major challenges, such as the coverage of the population's food and nutrition needs [2, 3]. In 2013, livestock in Benin covered an estimated herd of 2.166 million head of which 2.116 million is the share of bovine species [1]. They are concentrated at 85% in the North of the country with 63% in Borgou and Alibori areas [4]. Milk and dairy products occupy a prominent place in the human nutrition [5] in West Africa countries in general and in Benin in particular [6, 7]. They are excellent sources of high value proteins, calcium, vitamins, trace elements [8] and contribute more than 50% of the annual income of Fulani households in Benin [9]. Nevertheless, despite their social, economic and nutritional importance in West Africa and Benin in particular, their production remains weak [10] and does not guarantee the safety of consumers [9, 11, 12, 13]. This situation is partly due to the variability of several factors such as the cattle breeds, the production environment, the poor hygiene conditions of equipment used for milking, the infection of the udders of the cows and the milk storage conditions often depending on the socioeconomic realities [5, 10, 11, 13-16]. This review discusses the performance of cattle breeds involved in dairy production in Benin, gives some figures to assess the importance of milk and milk products in Beninese dietary habits and exposes the health hazards associated with the consumption of milk and dairy products in Benin.

## PRESENTATION OF BENIN AND CATTLE BREEDING

Benin is located in West Africa in the Tropical zone between the Equator and the Tropic of Cancer. It is limited to the North by the Niger River, in the North West by Burkina Faso, in the East by Nigeria, in the West by Togo and in the South by the Atlantic Ocean (Figure 1). Characterized by two types of climate, it's subdivided into 77 municipalities grouping 5 agro pastoral areas

(Table 1) (Livestock Directorate, 2012). Benin imports live animals, mainly sheep/goats and cattle from neighboring countries. Niger and Nigeria are the main sheep/goats suppliers, while Niger and Burkina Faso provide a large proportion of cattle in large numbers in the North [17, 18]. In the Southern Benin, on the other hand, there is a sedentary breeding of cattle which herds are small (3 to 10 heads) [17]. Cattle breeding in Benin is unequally distributed and based on two animal production system (traditional and modern) because of the potential and constraints of the agro pastoral areas. Based mainly in the North of the country, the traditional production system is the most represented, given the potential of the area and its low human density. It supplies 85% of the national cattle herd [19]. The modern system, meanwhile, is characterized by a health monitoring of the herd, an improvement of cattle breeds and food complementation without transhumance. It occupies only 2% of the breeders and is practiced in the government farms (Okpara, Betecoucou, Samiondji, and Kpinnou) [20].

## CATTLE BREEDS FOR MILK PRODUCTION IN BENIN

Benin has a large cattle herd diversified by local breeds and adapted to the different climatic conditions (Table 2). The main breeds are the Somba, Lagoon, Borgou, Bulls and zebu, especially the Fulani zebu, M'Bororo and Goudali [21]. In addition to these cattle breeds, there are exotic Girolando breed imported from Brazil and the crossbreds from the Girolando breed and the local breeds. These different breeds provide the bulk of milk and the local production of meat. Among all these breeds, the Borgou breed is the most encountered in Benin and represents 51% of the national cattle herd [22]. The Lagoon breed is the most popular breed in the South of the country [19]. Its low milk productivity (0.63L/day) has led to crosses with the Azawak zebu, known for its high milk performance (4.5L/day) in order to improve the level of milk production [21, 23]. Also, to increase the milk production at the national level, the Girolando breed was brought to Benin in 2004 and experienced on the Kpinnou Farm located in the South of the country. The results of the various studies focusing on milk production and growth performance [19, 23, 24] have allowed to summarize in Table 2 the Benin cattle breeds involved in the milk production and their potential.

Table 1. Features of Benin's agro pastoral areas [20]

Features	Geographic Situation	Climate	Availability Forage	Milk Production
Zone I	Alibori North-West	Sudano Sahelian	***	****
Zone II	Atacora Borgou	Sudanese	***	***
Zone III	South Borgou South Atacora	ND	***	***
Zone IV	ND Atlantic,	Sudano Guinean	****	**
Zone V	Mono, Zou, Oueme	ND	****	*

\*: Weak; \*\*: Average; \*\*\*: Strong; \*\*\*\*: Very strong; ND: Not Defined

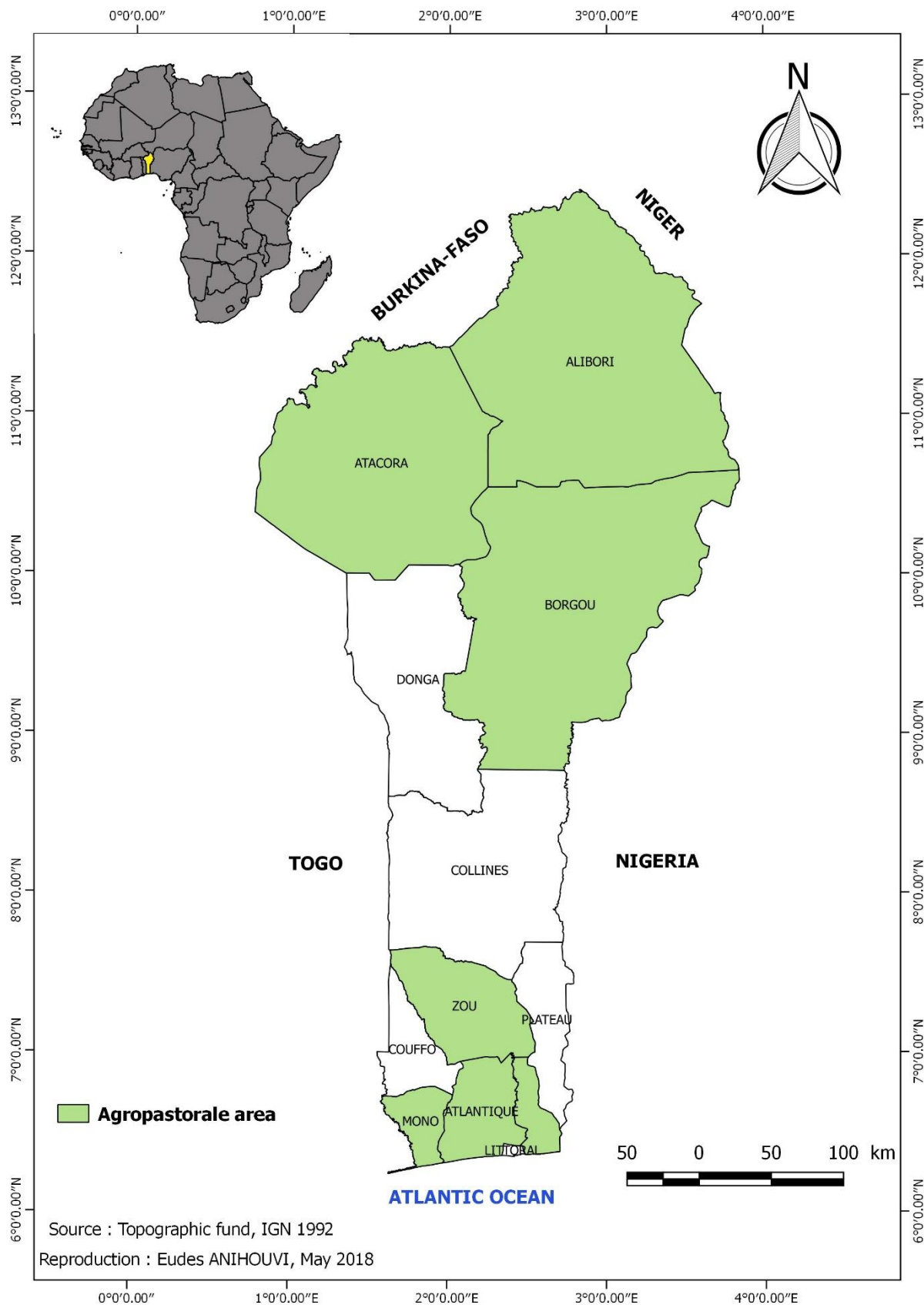


Figure 1. Map of Benin showing agro-pastoral areas

## MILK AND DAIRY PRODUCTS IN BENIN'S NUTRITIONAL HABITS

Economies of most African countries in south of Sahara, including Benin, is mainly based on agriculture and livestock [25, 26]. Among livestock products, cow's milk has a great socioeconomic importance. In Benin, milk contributes more than 50% of annual household income of Fulani sociocultural group and is consumed in many forms [9, 11, 26]. In this respect, a range of milk and dairy products make up the Beninese market. This diversity ranges from raw milk produced locally or imported (whole, half-skimmed, skimmed) to processed milk (Milk powder, curd, yogurt, cheese, butter). There is also a fermented beverage (made from cow milk and

cereals) commonly called "Degue" [20] and the Fulani cheese locally produced, called "Wagashi" [27]. This diversity of food is explained by the existence of a great number of food usage among urban consumers [28]. Until recently, very little data on the socio-economy of dairy consumption in Africa is available. Too often, diagnoses have been based on approximations from national aggregates, including those published by FAO [28]. With this, we noticed an increase in domestic milk production and a decrease in imports of milk and dairy products in recent decades (Table 3) [29]. Thus, the increase of domestic milk production led to a decrease in imports of milk and dairy products with the effect of segmenting the dairy markets where local products play a significant role.

Table 2. Cattle breeds involved in the milk production in Benin and their potential

Cattle Breeds	Origins	Area of Distribution	Average Milk Production (L/d ; Kg/d)*	Sources
Lagoon Bull	Benin : South	Benin, Guinea, Ivory Coast, Ghana	- 0.36 L/d in extensive Breeding	[30]; [31]
Somba Bull	Benin : Atacora	Benin, Togo	- 0.48 L/d in extensive Breeding	[31]; [32]
Borgou Cattle	Benin : Borgou	Benin, Togo, Burkina Faso, Nigeria	- 0.8-1.30 L/d in extensive breeding - 0.8-1.77 L/d in semi-intensive breeding	[21]; [31]; [33]; [34]
M'Bororo Zebu	Niger	Niger, Sudan, Nigeria, Mali, Burkina Faso, Benin	- 1.75 L/d in extensive breeding	[21]; [31]
Azawak Zebu	Niger : Azawak Valley	Niger, Mali, Burkina Faso; Benin	- 4.5 L/d in extensive breeding - 6.74 L/d in semi-intensive breeding	[31]; [35]; [36]
White Fulani Zebu	Niger, Nigeria	Niger, Nigéria, Mali (Macina), Benin	- 1.52 L/d in extensive breeding - 2.65 L/d in semi-intensive breeding - 3.14 L/d in intensive breeding	[31]; [36]; [37]
Goudali Zebu	Nigeria	Nigeria, Niger, Benin	- 3.7 kg sedentary extensive breeding - 4.7 kg in transhumant extensive breeding	[31]; [38]
Crossbred Azawak x Lagoon	Benin	Samiondji (Southern Benin)	- 0.75 L/d in semi-intensive breeding	[21]; [31]
Girolando Cattle	Brazil	Brazil, Senegal, Benin	- 6.33 kg in semi-intensive breeding - 6.85 kg in semi-intensive breeding - 12 L/d in intensive breeding	[19]; [31]; [39]
Girolando x Borgou	Benin	Benin	- 5.5 L/d in semi-intensive breeding	[31]; [40]
Gir x Borgou	Benin	Benin	- 10 L/d in semi-intensive breeding	[21]; [31]
Holstein x Borgou	Benin	Benin	- 3 L/d in semi-intensive breeding	[21]; [31]

\*L/d: liter/day; kg/d: kilogram/day

## PROCESSING OF FRESH MILK INTO DAIRY PRODUCTS IN BENIN

In Benin, the cattle breeding occupies a significant place, although there are also production systems based on the breeding of others species. Cows are mainly raised for their milk that is consumed in many forms: fermented milk mixed with millet "Degue" [27] and Fulani cheese "Wagashi" [26, 41]. These products considered as "traditional products" are associated with a local cultural identity and testify to the variety of milk derivative products available to the consumers.

*Production of Wagashi:* Artisanal know-how has led to the production of Fulani cheese commonly known as "Wagashi". Produced in the Northern part of the country, this soft cheese is highly valued by both Beninese and immediate neighbors. It's consumed as a substitute of meat and fish in various dishes [42, 43]. Wagashi is an important source of animal protein, especially for people

with low incomes and could efficaciously contribute to solving problems related to proteins deficiency in the diets in Africa [44]. Consumed throughout the country in various forms (fresh, fried, grilled), the production of Fulani cheese is still rudimentary and traditional [41]. The processing of fresh milk into Wagashi (Figure 2) is based on the enzymatic coagulation of raw whole cooked cow's milk with the extract of the sodom apple (*Calotropis procera*) leaves [41].

*Production of Degue:* Most fermented products in Benin, are based on cereals. Cereals are available throughout the country and used in the food manufacturing. They consist mostly of maize, millet and sorghum. Degue is a beverage that can be described as a mixture of fermented milk and millet. It's widely consumed in Benin and beyond to West Africa. The process of Degue's production is shown in Figure 3.

Table 3. Evolution of milk production and dairy product importation in Benin: 2005-2016 [29]

Year	Milk Production (tons)	Milk/Milk Products Import*	Milk Import**
2005	87196	9181	84766
2006	89673	9738	86673
2007	92001	10472	86905
2008	94379	10451	92189
2009	96807	12926	96018
2010	99334	7201	98368
2011	101959	5718	ND
2012	104576	4970	103566
2013	107254	3803	106189
2014	110066	ND	ND
2015	112950	ND	ND
2016	113816	ND	ND

\*: Importation of Milk and dairy products in tons; \*\*: Importation of Milk in tons (Whole Powdered, Whole Concentrated, Skimmed); ND: not defined.

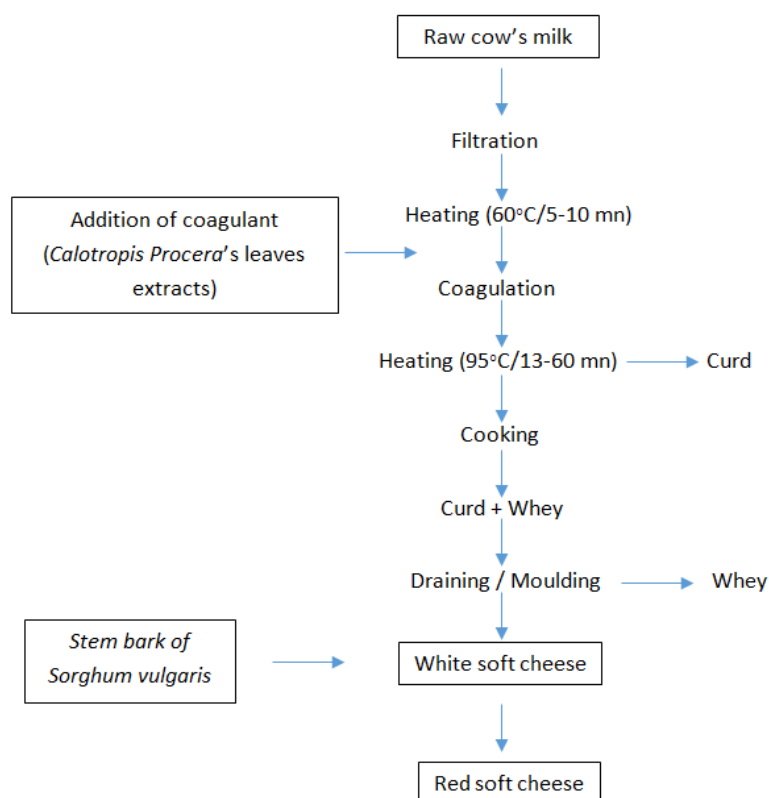


Figure 2. Diagram of production of Peulh cheese [44, 41]

### HEALTH HAZARD RELATED TO THE CONSUMPTION OF MILK AND DAIRY PRODUCTS IN BENIN

Because of its richness in water and other constituents, milk is a very perishable product. Its chemical composition thus exposes it to a rapid degradation in peasant areas. These peasant areas are often characterized by low technological level and limited means of conservation. This reality affects the health safety of the consumers and thus, deserves a special attention from milk production to the various by products. Indeed, raw cow milk could be contaminated by microbial agents responsible for food poisoning such as *Salmonella* [16, 45-48] and enteropathogenic strains of *Escherichia coli* producing verotoxins [16, 49-52].

Similarly, others agents (staphylococcal and mycotoxicosis) responsible for severe intoxication [16, 53] could also be found in milk. The work on the microbiological quality of milk and derivatives product in Benin has revealed the existence of real public health problems. These works reported high contamination of raw cow's milk in total coliforms, thermotolerant coliforms, *Escherichia coli*, *Staphylococcus aureus*, sulphite-reducing anaerobes, yeasts and molds [12, 16]. These strong contaminations could not be only linked to the health status of the dairy herd [15, 16]. It may be also due to the poor hygiene conditions of the utensils used for milking and the storage conditions [5, 14, 15, 16]. The presence of these bacteria in milk may be linked to the contamination by cow dung, the soil, the quality of the water used and the hands of the milker [16, 54].

They are also indicative of: poor hygienic practices during milking and post-handling [16]; the presence of other pathogenic enterobacterium and risk of enterotoxin production (*Staphylococcus aureus*) [16, 54].

**Wagashi:** Recognized as traditional cheese locally produced, Wagashi is a good proteins source with high water content (60%), which undoubtedly promotes the growth of microorganisms negatively impacting its quality [11]. The work of [12] and [13] on the microbiological quality of the cheese-based of cow's milk sold in the urban markets of Benin showed that the concentration of pathogenic microorganisms such as faecal coliforms, *Escherichia coli*, and moist exceed the regulatory limits set by some international organizations (WHO, the Codex Alimentarius or the European Union).

The presence of moist should make us think of other contaminant like aflatoxins M generally found in milk and cheeses. Likewise, due to the lack of a cold chain, several traditional methods of preservation of Wagashi have been developed in Africa and particularly in Benin [11, 44]. The main practices were sun drying, followed by whey conservation, soaking in untreated water or colored water with *Sorghum vulgaris*, traditional smoking and frying [11]. Unfortunately, none of these methods contributes to enhance the quality of Wagashi for more than twelve (12) days. The factors involved in the short shelf life of Wagashi despite of all these different methods may be related to the quality of the milk used, the lack of appropriate method for preservation, the contamination by molds, the quality of feed of animals from which the milk is obtained, the conditions of transporting/marketing and the water used [11].

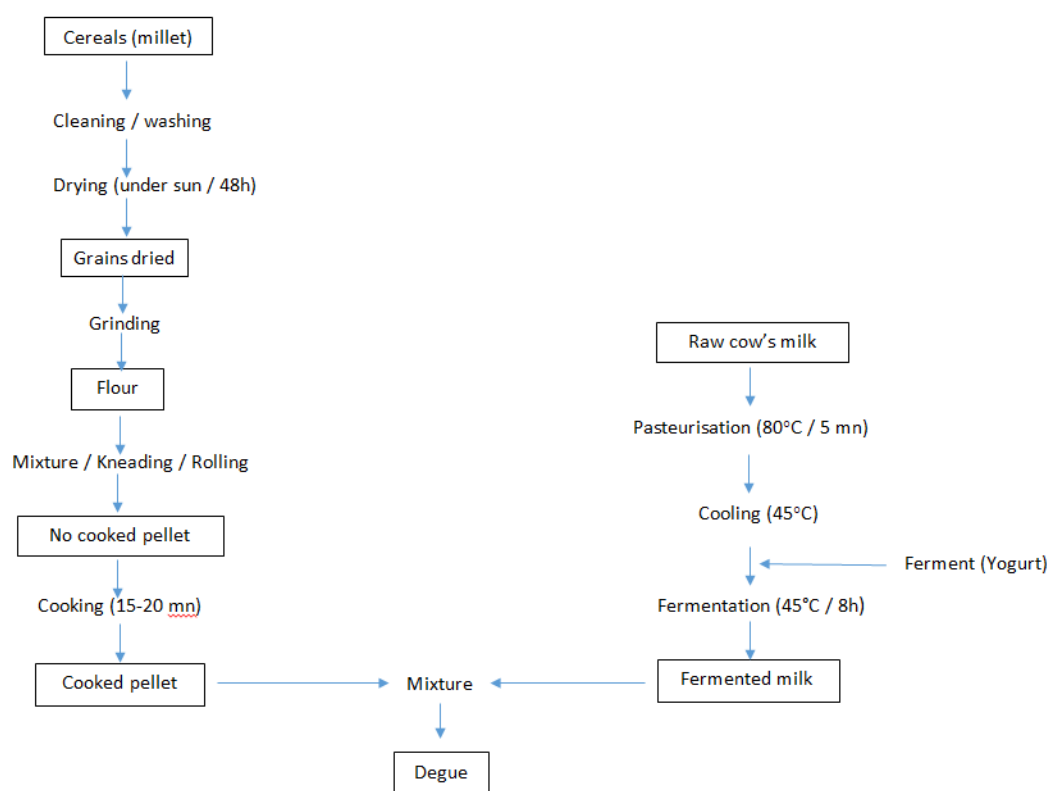


Figure 3. Diagram of Degue's production [27]

Indeed the water (backwater and the river water) used for production or conservation of Wagashi is often of poor hygienic quality. Degbey et al. [55] and Sessou et al. [11] showed that backwater and the river water may carry pathogens such as *E.coli*, *Klebsiella*, *Salmonella*, *Citrobacter*, *Enterobacter* and *Enterococcus*, *C.perfringens*, *Pseudomonas aeruginosa*, *Shigella* spp., *Candida albicans*, *Staphylococcus aureus*, *Giardia lamblia*, *Cryptosporidium* and human enteric viruses. In the same time, Wagashi is packaged and transported under poor hygienic conditions. Packed in stored bags and in bowls or baskets and cut containers, Wagashi is transported at ambient temperature (25 to 45°C) from the production place to the sellers' home or market, sometimes during several hours [11].

**Degue:** The local name Degue referred to traditional fermented beverage made with cow's milk and cereals (maize, sorghum and millet) pellet. Tchekessi et al. [27] reported that total mesophilic aerobic bacteria, yeasts and molds account in the Degue were higher than the values set by AFNOR (French Standards Association) for yoghurt. Also, regarding to lactic acid bacteria, the values obtained are consistent with standards ( $\geq 10^7/g$ ) set for yoghurt and probiotic fermented milks by AFNOR NF V 04-600, 2001 [27, 56]. Total and thermotolerant coliforms, *Staphylococcus aureus* and *Salmonella* didn't grow after sowing. This shows that the production of Degue respect the standards of viewpoint hygienic quality. The dominant flora of Degue is constituted of lactic acid bacteria, yeasts and molds. Therefore, the introduction of cereals flour dumplings would further enriched in milk fermented by lactic acid bacteria, yeasts

and molds. Degue contain no coliforms, *Escherichia coli*, *Staphylococcus aureus* and *Salmonella*. These manufactured products comply thus with the microbiological standards. Degue millet has great nutritional importance. Moreover, they can be classified as probiotic foods because containing significant living cells capable to improve the intestinal flora of the consumer by giving it more immunity [27].

## CONCLUSION

Benin has a large diversity of cattle resources with a level of production influenced by both production systems and environmental factors. This justifies the artisanal character of the dairy sector in Benin despite the various efforts to improve production. Traditional products made from milk, despite their unsatisfactory sanitary qualities, are able to provide a viable outlet for producers but unfortunately, these products show the concentration of pathogenic microorganisms beyond the regulatory limits set by the WHO, the Codex Alimentarius or the European Union. Therefore, there is a threat for the health of the populations consuming cow's milk and by products. Thus in perspective, it would be wise to develop conservation or processing technics based on the socio-economic and environmental realities, to assess the characteristics of other dairy breeds to determine those with the best nutritional and technological features, to optimize based on these results the milk production through genetic improvement and nutritional supplementation which will undoubtedly allow an industrial valorisation and finally, to develop some new products in order to diversify the local market and confer to the consumers a health benefits beyond his inherent basic nutrition. This would provide to these local dairy products all the place they deserve.

## REFERENCES

- [1] FAO (2015). FAO Stat, [faostat.fao.org/site/613/DesktopDefault.aspx?PageID=613#ancor](http://faostat.fao.org/site/613/DesktopDefault.aspx?PageID=613#ancor), (Viewed 18/12/2017).
- [2] MAEP. (2011). Stratégie de croissance pour la réduction de la pauvreté. Rapport d'activité 2011-2015, Direction de l'élevage du Benin, 100p.
- [3] PAFILAV. (2014). Rapport synthèse définitif sur l'étude des filières lait et viande au Bénin, 213p.
- [4] FAO (2013). Country Stat, [www.countrystat.org/home.aspx?c=ben&ta=053SPD135&tr=21](http://www.countrystat.org/home.aspx?c=ben&ta=053SPD135&tr=21), (Viewed 18/12/2017).
- [5] Wattiaux, M.A. (1997). Dairy essentials (1st edition): Lactation and milking. The Babcock Publications, University of Wisconsin-Madison, 73-100.
- [6] Dossou, J., Adote, S., Soulé, H. (2006). Fiche technique de production et transformation du lait frais en fromage peulh au Bénin. Guide de Bonnes Pratiques, 33p.
- [7] Chapon, M., Tourette I. (2011). Filière Lait Local en Afrique de l'Ouest, rôle des OPR, des petits et moyens éleveurs dans la pleine expression de son potentiel. Actes de l'atelier tenu à Bamako du 15 au 17 septembre 2010, 70p.
- [8] Noblet, B. (2012). Le lait: produits, composition et consommation en France. *Cahiers de Nutrition et de Diététique*, 47(5), 242-249.
- [9] Ogodja, J.O., Hounsou-Ve, G., Dehoux, J.P. (1991). Rôle et activité de la femme peulh dans son ménage dans le Sud Borgou au Bénin. Part1.
- [10] Corniaux, C., Lesnoff, M., Ickowicz, A., Hiernaux, P., Diawara, M.O., Sounon, A., Aguilhon, M., Dawalak, A., Manoli, C., Assani, B., Jorat, T., Chardonnet, F. (2012). Dynamique des cheptels de ruminants dans les communes de Tessékéré (Sénégal), Hombori (Mali), Dantiandou (Niger) et Djougou (Bénin). Agence Nationale de la Recherche (ANR), Elevage Climat et Société (ECLiS), 43p.
- [11] Sessou, P., Farougou, S., Azokpota, P., Youssao, I., Yèhouenou, B., Ahounou, S., Sohounhloué, D.C.K. (2013). Endogenous methods for preservation of Wagashi, a Beninese traditional cheese. *Academic Journals*, 8 (31), 4254-4261.
- [12] Dossou, J., Atchouké, G.D., Dabadé, D.S., Azokpota, P., Montcho, J.K. (2016). Évaluation Comparative De La Qualité Nutritionnelle Et Sanitaire Du Lait De Différentes Races De Vaches De Quelques Zones D'élevage Du Bénin. *European Scientific Journal*, 12(03), 141-159.
- [13] Fadéby, M.G., Assongba, H., Assogba, G.M. (2017). Evaluation of the microbiological quality of the cheese-based of cow's milk sold in the markets of Porto-novo (Benin). *The International Journal of Science & Technology*, 10(1), 210-217.
- [14] Youssao, A.K.I. (2015). Programme National d'Amélioration Génétique. Projet d'Appui aux Filières Lait et Viande (PAFILAV), Bénin, 344p.
- [15] Aumaitre, A. (1999). Quality and safety of animal products. *Livestock Production Science*, 59, 113-124.
- [16] Farougou, S., Kpodékon, T.M., Sessou, P., Youssao, I., Boko, C., Yèhouenou, B., Sohounhloué, D. (2011). Qualité microbiologique du lait cru de vache élevée en milieu extensif du Bénin. Actes du 3ème Colloque des Sciences, Cultures et Technologies de l'UAC-Bénin.
- [17] Aboh, A.B., Mekhtoub, K., Ouedraogo, S., Pham, T.H.R., Rivera, A.M. (2001). Importance, contraintes et voies de développement des élevages urbains et périurbains dans la Région Sud du Bénin. Série de Documents de Travail N° 96 Bénin-2001, 146p.
- [18] Tir, Elhadj, Bounoua, S., Heddar, M., Bouklila, N. (2015). Etude de la qualité physico-chimique et microbiologique de laits crus de vache dans deux fermes de la wilaya de Tissemsilt (Algérie). *ElWahat pour les Recherches et les Etudes*, 8(2), 26-33.
- [19] Alkoiret, I.T., Yari, H.M., Gbangboché, A.B., Lokossou, R. (2011). Reproductive performance and milk production of Girolando cows in the ranch of Kpinnou, South-West of Benin Republic. *Journal of Animal and Veterinary Advances*, 10(19), 2588-2592.

- [20] Mama Sombo, A. (2013). Programme d'actions détaillé du développement de la filière lait en zone UEMOA. Rapport final CIRAD étude filière lait, Bénin, 44p.
- [21] Youssao, A.K.I., Dahouda, M., Attakpa, E.Y., Koutinhouin, G.B., Ahounou, G.S., Toléba, S.S., Balogoun, B.S. (2013). Diversité des systèmes d'élevages de bovins de race bovine Borgou dans la zone soudanienne du Bénin. *International Journal of Biological and Chemical Sciences*, 7(1), 125-146.
- [22] Ministère de l'Agriculture, de l'Elevage Et de la pêche Bénin (MAEP). (2007). Rapport annuel d'activité 2006, Direction de l'élevage du Benin.
- [23] Adjou Moumouni, P.F. (2006). Evaluation zootechniques des performances des bovins de race Borgou en sélection à la ferme d'élevage de l'Okpara-Bénin. Thèse de Doctorat de Médecine Vétérinaire, Ecole Inter-Etats des Sciences et Medecine Veterinaires (Eismv), Dakar, 20p.
- [24] Youssao, A.K.I., Koutinhouin, G.B., Kpodekon, T.M., Yacoubou, A., Bonou, A.G., Adjakpa, A., Ahounou, S., Taiwo, R. (2009). Amélioration génétique des performances zootechniques du porc local Béninois par croisement avec le Large White. *International Journal of Biological and Chemical Sciences*, 3(4), 653-662.
- [25] Meyer, C., Denis, J.P. (1999). Elevage de la vache laitière en zone tropicale. Edited by C. Meyer, J.P. Denis, Cirad, Montpellier, 314p.
- [26] Diao, X., Hazell, P., Resnick, D., Thurlow, J. (2006). The role of agriculture in development: implications for Sub-Saharan Africa. *International Food Policy Research Institute*, 112p.
- [27] Tchekessi, C.K.C., Bokossa, Yaou, I., Banon, J., Agbangla, C., Adeoti, K., Dossou-Yovo, P., Assogba, E. (2013). Caractérisations physico-chimiques et microbiologiques d'une pâte traditionnelle "gowé" fabriquée à base de maïs au Bénin. *Journée Recherches des Sciences Universitaires*, Lomé (Togo), Série A, 15(2), 377-387.
- [28] Deteurtre, G., Corniaux, C., Boutonnet, J-P. (2003). Baisse de la consommation des produits laitiers en Afrique subsaharienne: mythe ou réalité? *Rencontre Recherche Ruminants*, 10, 321-326.
- [29] FAO (2017). Services statistiques de la FAO. [www.fao.org/faostat/en/#data](http://www.fao.org/faostat/en/#data), Viewed 20/02/18.
- [30] Belemsaga, D., M., A. (2000). Contribution à l'analyse d'échantillons biologiques par des méthodes physico-chimiques et nucléaires. Thèse du 3ème cycle: Physique Nucleaire, Dakar, Sénégal, 170p.
- [31] Kassa, K., Ahounou, S., Guiguigbaza-Kossigan, D., Salifou, C., Issifou, M.T., DOTCHÉ, I., Gandonou, P.S., Yapi-Gnaoré, V., Koutinhouin, B., Mensah, A.G., Youssao, A.K.I. (2016). Performances de production laitière des races bovines de l'Afrique de l'Ouest. *International Journal of Biological and Chemical Science* 10(5), 2316-2330.
- [32] Kassa, K., Moutouama, V. (2009). Productivité de la race bovine Somba dans le département de l'Atacora: cas de la commune de Boukombé. Mémoire de Licence Professionnelle en Production et Santé Animales. Département de Production et Santé Animales. Ecole Polytechnique d'Abomey Calavi, Université d'Abomey-Calavi, Bénin, 49p.
- [33] Gbangboché, A.B., Alkoiret, T.I. (2011). Reproduction et production de lait des bovins de race Borgou et N'Dama au Bénin. *Journal of Applied Biosciences*, 46, 3185-3194.
- [34] Gbdjo, Z.L., Sokouri, D.P., Bi, S.G., N'Goran, K.E., Fofana, I.J., Soro, B., N'Guetta, A.S.P. (2014). Potentialities of Dairy Production of Local Cattle Raised in Rural Environment in Northern Ivory Coast. *Global Journal of Animal Scientific Research*, 2(3), 260-269.
- [35] Cissé, S. (2000). Stratégie nationale en matière de diversité biologique. *Tome 1: situation générale de la diversité biologique* au Mali, 122p.
- [36] Ouédraogo, A. (2013). Etude des performances laitières des vaches zébus et de la croissance pondérale des veaux des noyaux de Ouagadougou et Komsilga. Mémoire d'Ingénieur de Conception en Vulgarisation Agricole, Institut du Développement Rural, Université Polytechnique de Bobo-Dioulasso, Burkina-Faso, 76p.
- [37] Meyer, C. (2018). Dictionnaire des Sciences Animales [Online]. *Cirad*, Montpellier, France. [www.dico-sciencesanimales.cirad.fr](http://www.dico-sciencesanimales.cirad.fr), Viewed 02/01/2018.
- [38] Assani, S., Assogba, B., Toukourou, Y., Alkoiret, I.T. (2015). Productivity of Gudali cattle farms located in the commons of Malancity and Karimama extreme north of Benin. *Livestock Research for Rural Development*, 27(7), 1-9.
- [39] Doko, A.S., Gbégo, Tossa, I., Tobada, P., Mama, Yari, H., Lokossou, R., Tchobo, A., Alkoiret, T.I. (2012). Performances de reproduction et de production laitière des bovins Girolando à la ferme de Kpinnou au Sud-Ouest du Bénin. *Bulletin de la Recherche Agronomique du Bénin (Numéro spécial Elevage & Faune)*, 36-47.
- [40] PDE. (2008). Rapport annuel d'activités du Projet de Développement de l'Elevage, 97p.
- [41] Aïssou, R.C.B., Aïssi, V.M., Youssao, A.K.I., Soumanou, Mohamed, M. (2015). Caractéristiques physico-chimiques du fromage Peulh produit dans les conditions optimales de coagulation à partir du lait de deux races de vaches du Bénin. *Revue «Nature & Technologie»*. B- Sciences Agronomiques et Biologiques, n° 14/ Janvier 2016, 37-43.
- [42] Kees, M. (1996). Le fromage peulh : facile à produire et bien apprécié, une technologie à vulgariser. Rapport de recherche GTZ, Université Eschborn, 8-25.
- [43] Aïssi, V.M., Soumanou, M.M., Bankolé, H., Toukourou, F., De Souza, C.A. (2009). Evaluation of hygienic and mycological quality of local cheese marketed in Benin. *Australian Journal of Basic Applied Sciences*, 3(3), 2397-2404
- [44] Kèkè, M., Yèhouénou, B., Dahouénon, E., Dossou, J., Sohounhloué, D.C.K. (2008). Contribution à l'amélioration de la technologie de fabrication et de conservation du fromage peulh waragashi par injection de *Lactobacillus plantarum*. *Annales des Sciences Agronomiques du Bénin*, 10(1), 73-86.



- [45] D'aoust, Y.L. (1991). Pathogenicity of food borne Salmonella. *International Journal of Food Microbiology*, 12, 17–40.
- [46] Steele, M.L., Mcnab, W.B., Poppe, C., Griffiths, M.W., Chen, S., Degrandis, S.A., Fruhner, L.C., Larkin, C.A., Lynch, J.A., Odumeru, J.A. (1997). Survey of Ontario bulk tank raw milk for food-borne pathogens. *Journal of Food Protection*, 60, 1341–1346.
- [47] Headrick, M.L., Korangy, S., Bean, N.H., Angulo, F.J., Altekruze, S.F., Potter, M.E., Klontz, K.C. (1998). The epidemiology of raw milk-associated foodborne disease outbreaks reported in the United States, 1973 through 1992. *American Journal of Public Health*, 88, 1219–1221.
- [48] Farhan, M., Salik, S. (2007). Evaluation of Bacteriological Contamination in Raw (Unprocessed) Milk Sold in Different Regions of Lahore (Pakistan). *Journal of agriculture and social sciences*, 3, 104–106.
- [49] Lechevallier, M.W., Werch, N.J., Smith, D.B. (1996). Full-scale studies of factors related to Coliform regrowth in drinking water. *Applied and Environmental Microbiology*, 62, 689–93.
- [50] Jacques, V., Charles, D., Laurence, N., François, M., Claude, J., Emile, P., Mohamed, EL, L., Jacques D. (1998). Qualité microbiologique des fromages artisanaux fabriqués au lait cru en Région wallonne. *Biotechnologie, Agronomie, Société et Environnement*, 2, 248-255.
- [51] Stark, K.D. (2000). Food safety achieved through herd management. *Schweiz Arch Tierheilkd*, 142, 673–678.
- [52] Mennane, Z., Ouhssine, M., Khedid, K., EL Yachoui, M. (2007). Hygienic quality of raw cow's milk feeding from domestic waste in two regions in Morocco. *International Journal of Agriculture and Biology*, 9, 46–48.
- [53] Adesiyun, A.A., Webb, L., Rahaman, S. (1995). Microbiological quality of raw cow's milk at collection centers in Trinidad. *Journal of Food Protection*, 58, 139–146.
- [54] Chye, F., Abdullah, A., Ayob, M. (2004). Bacteriological quality and safety of raw milk in Malaysia. *Food Microbiology*, 21, 535–541.
- [55] Degbey, C., Makoutode, M., Agueh, V., Dramaix, M., De Brouwer, C. (2011). Facteurs associés à la qualité de l'eau de puits et prévalence des maladies hydriques dans la commune d'Abomey-Calavi (Bénin). *Cahier Santé*, 21, 47-55.
- [56] Beal, C., Sodini, I. (2003). Fabrication des yaourts et des laits fermentés. *Techniques de l'ingénieur*, F6 315-7, 31p.
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