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Socio-Economic Determinants of Goat Milk Consumption by Rural Households in the Niger Valley of Benin and Implications for the Development of a Smallholder Dairy Goat Program

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Goats, more popular than cattle in rural Benin, are mainly kept for meat production. Their milk is still unpopular but can provide the much-needed nutrients for children in food-insecure households. This study explored the socio-economic factors affecting the attitude of rural households in the Niger Valley of Benin toward goat milk consumption. Data were collected through individual face-to-face interviews of 721 heads of households or their representatives. Binary logistic regression analysis was carried out to test the association between socioeconomic variables and goat milk consumption. Goat milk and its products were consumed in 14.7% of the surveyed households and were not part of the traditional diets of remaining 81.8%. Their sensory qualities were further reasons reported by 18.4% of respondents for their non-consumption. A household's likelihood to consume goat milk or its derivatives was significantly influenced by the sociocultural background of its head and whether it kept goats or not. The odds of consuming goat milk and/or its derivatives were 2.285 and 2.017 times higher, respectively, for households from *Dendi* and *Peulh* socio-cultural groups. Despite the recorded cultural barriers, there is room for increasing goat milk consumption by rural households by increasing its availability and raising awareness of its nutritional and health benefits.

Keywords: cultural barriers, food security, goat milk, nutrition sensitive goat farming, rural people, West Africa

INTRODUCTION

As in most Sub-Saharan African countries, goat farming is very popular in Benin, especially in rural areas. Goats represent an important asset to rural households, providing them with several tangible and intangible benefits (Dossa et al., 2015; Kaumbata et al., 2020). Beyond their role as a source of food (meat and milk) and nutrition security, goats are an important provider of income, savings, insurance, and manure for crop fertilization. Goats also have important socio-cultural functions,

as their slaughtering and/or consumption are imperative during certain religious celebrations or rituals (Dossa et al., 2008).

Two goat types are generally kept in Benin: the Djallonké or West African Dwarf goat and the Sahelian goats. The Djallonké goat, the most dominant, is very well-adapted to the environmental and health conditions of humid and sub-humid areas, whereas the Sahelian goat is commonly raised in the semi-arid and arid zones of the North of the country to which it is well-adapted. Depending on the breed, the Sahelian goat can produce up to 540 ml and 574 ml milk in an average lactation period of 3.6 months (Missohou et al., 2004; Nantoumé et al., 2011) against 88 ml −320 ml (Ahamefule and Ibeawuchi, 2005; Jaitner et al., 2006) for the West African Dwarf goat.

While the role of goats in providing milk for human consumption has been increasingly recognized worldwide, as evidenced by the rapidly expanding global dairy goat industry (Liang and Devendra, 2014; Miller and Lu, 2019), indigenous goats in Benin are still primarily raised for meat. As in other countries in Sub-Saharan Africa, government-led research and dairy development programs have prioritized cattle and overlooked the milk production from goats (Kahi and Wasike, 2019; Sow et al., 2021). However, goats, and especially dairy goats, because they are less responsive than cattle to climate changes and its negative effects (Kabubo-Mariara, 2008; Nair et al., 2021), might represent a better alternative to cattle for resource-poor farmers (Klapwijk et al., 2014). Further advantages of goats over cattle include their significant lower feed requirements, lower capital investment and production costs, shorter generation intervals, effective use of family labor, including women and children, reduced problems of storage and distribution of milk, and production of milk for mainly household consumption and nutrition (Devendra, 2012). However, despite the widespread keeping of goats in the rural areas of Benin, and to our best knowledge, there is to date no scientific publication exploring the potential role that plays goat milk in the diet of the rural Beninese populations, particularly those living in the semi-arid regions of the country, where a high prevalence of chronic malnutrition among children under 5 years of age (around 35%) has been reported (Akombi et al., 2017; Odjidja and Hakizimana, 2019).

Numerous publications (Tomotake et al., 2006; Park and Haenlein, 2007; Claeys et al., 2014; Kanekanian, 2014; Pereira, 2014; Kalyankar et al., 2016; Gebreyowhans et al., 2020; Prosser, 2021) have highlighted out the importance of milk in general, and more particularly of goat milk, and its processed products as functional foods for human nutrition. Since the late 1800s, commercially prepared infant formulas made with cow milk have been used for feeding infants when adequate breastfeeding is impossible (Fomon, 2001). But, as cow milk is not suitable for all infants due to allergies, it has been increasingly replaced by non-bovine milk, such as goat milk (Byrne et al., 2021). Goat milk, compared with cow milk, contains a higher proportion of small fat globules (Gallier et al., 2020) and proteins with higher nitrogen use (Ye et al., 2019). It also has some greater medical properties (Lund and Ahmad, 2021; Nayik et al., 2021; Rubin et al., 2021) including the prevention of cell entry and replication of pseudovirus SARS-CoV-2 (Rubin et al., 2021), and lower risks of allergy (Haenlein, 2004; Tomotake et al., 2006; Gebreyowhans et al., 2020). Recent studies have shown that protein and fat in goat milk-based infant formula are more readily digested (Maathuis et al., 2017; Ye et al., 2019) with digestion kinetics and lipid composition and structure closer to that of human milk than to that of cow milk-based formula (Gallier et al., 2020; He et al., 2022). Furthermore, goat milk contains minor dietary (Tolenaars et al., 2021) and potential bioactive components, imperative for the proper metabolism and functioning of the human body (Nayik et al., 2021).

Besides the goat milk, goat milk products are considered to have great marketing potential (Devendra and Liang, 2012; Miller and Lu, 2019). According to Zenebe et al. (2014), fermented goat milk incorporating live probiotic cells, represents a group of products with great prospects in the future due to their nutritive and therapeutic properties. Furthermore, the production of cheese made with goat milk has a very long history and is an important source of protein for people in several countries (Yangilar, 2013).

All the aforementioned characteristics make goat milk and its processed products valuable but neglected sources of nutrients for malnourished rural Beninese people, especially children. Studies conducted in some Eastern and Southern (Mpofu et al., 2010; Jerop et al., 2014; Idamokoro et al., 2019) and Northern (Zine-eddine et al., 2021) African countries revealed the sensory attributes (taste and smell) of goat milk to be the most important factors that negatively affect its consumption. Further influential factors include its limited availability and relatively higher price compared with cow milk (Mpofu et al., 2010; Jerop et al., 2014). The findings of Mpofu et al. (2010), corroborated by a recent investigation by Idamokoro et al. (2019), have shown that the absence of goat milk habits and lack of knowledge about its health benefits were also considerable barriers to its consumption. As observed by Idamokoro et al. (2019), cultural beliefs and values can significantly influence the consumption of goat milk and its derivatives.

So far, however, there is very limited knowledge about rural households' attitudes toward goat milk and milk products consumption and its underlying factors in West Africa, in general, and in Benin in particular. Such knowledge is necessary for promoting more nutrition-sensitive village goat improvement programs. This study addressed the following question: what are the socio-economic factors that affect a household's consumption of goat milk and derived products in the Niger Valley of Benin?

MATERIALS AND METHODS

Study Area

This study was conducted between October and December 2018 in the municipality of Karimama and from October and December 2021 in the municipality of Malanville. Both municipalities are located in the department of Alibori in the Extreme North of Benin (**Figure 1**) and together constitute the Niger Valley of Benin. These two municipalities were chosen for this study because of the presence of some pockets of acute malnutrition (15.1% of Global acute malnutrition including 10.7% of Moderate

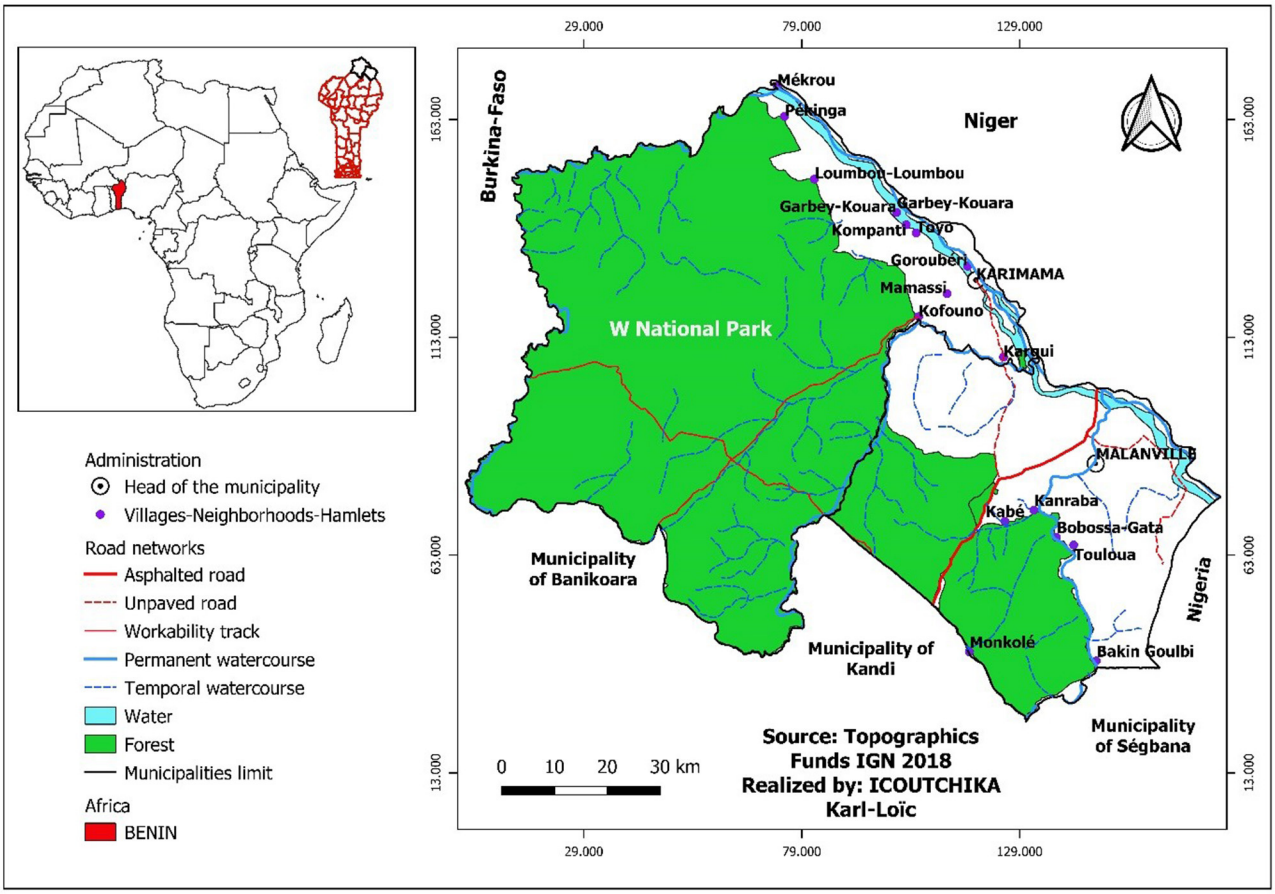

FIGURE 1 | Map showing the municipalities of Karimama and Malanville in North Benin.

acute malnutrition in Karimama, and (11.1% of Global acute malnutrition including 8.9% of Moderate acute malnutrition in Malanville) (INSAE, 2016) on one hand, and the widespread of goat farming, especially of long-legged Sahelian goat.

The Municipality of Karimama is limited in the North and West by the Republics of Niger and Burkina-Faso, respectively. Located about 780 km from Cotonou, the largest city of Benin, it counts five boroughs, namely, Birni-Lafia, Bogo-Bogo, Karimama, Kompa, Monsey, and 37 villages and hamlets. The annual rainfall is about 600 mm and the temperature ranges from 12° to 40°C. Its human population was estimated to be 66,353 in the last population census of 2013 (INSAE, 2016).

With an area of 3,016 km^2, or 2.63% of Benin's territory, the municipality of Malanville lies between 11.5° and 12° North latitude and between 2°45' and 3°40' East longitude. It is bordered to the North by the Republic of Niger, to the South by the municipalities of Kandi and Ségbana, to the West by the municipality of Karimama, and to the East by the Federal Republic of Nigeria. The municipality of Malanville is made up of five districts: Garou, Madécali, Malanville, Guéné, to the south and Timbuktu to the west (INSAE, 2016).

Household Sampling and Data Collection

The number of households to be surveyed was calculated using Dagnelie's formula (Dagnelie, 1998) as follows:

$$n = \frac{t_p^2 * P\,(1-P) * N}{t_p^2 * P\,(1-P) + (N-1) * y^2}$$

Where,

n is the sample size, and

N is the size of the target population (number of households in the municipalities of Karimama and Malanville), actual or estimated. The number of households in the municipalities of Karimama and Malanville according to the last General Census of Population and Housing was 9,168 and 23,072, respectively (INSAE, 2016).

P is the expected proportion of households keeping goats from the population or the actual proportion. It was set to 0.5 by default, which gives the largest possible sample.

tp is the sampling confidence interval, fixed at 1.96; and

y is the sampling error margin set to 5%.

The total calculated sample size was 747 households (369 households in Karimama and 378 in Malanville). Taking into account the probable refusals of some households to participate in the study, this size was increased by a margin of 14%. This study, therefore, included 852 households distributed throughout the municipalities.

To obtain a representative sample of the municipalities, 28 villages in Karimama and the largest district in Malanville were covered on the basis of their accessibility, the popularity of goat farming, and the presence of at least two goat types.

A structured questionnaire, organized in two sections, was used to collect data through individual interviews of a household member, preferably the household head. The first section of the questionnaire included information on the socio-economic characteristics of the surveyed households, such as the age, sex, and level of education of the head of household, household size, and composition, as well as the self-perceived household's financial status (poor, modest or rich). The second part was devoted to understanding the perceptions and attitudes of the respondents toward the consumption of goat milk and goat milk products. It included questions related to reasons for consumption or non-consumption by households, source of the goat milk and milk products consumed in case of consumption, and consumers' sensory perceptions (taste, color, and odor perceptions) of goat milk.

In each selected village, local authorities, i.e., village chiefs and/or their councilors, were the first people approached upon the arrival of the research team to present the objectives of the study and obtain their authorization to conduct the survey. No further institutional approval was required for conducting the survey, which was not considered intrusive. Nevertheless, oral informed consent was obtained from each respondent before the interview, as not all of them were educated and could provide written informed consent.

Data Analysis

After the removal of missing data due to either respondent refusal to complete the interview or inconsistencies in respondent's responses, 721 households were considered for further analyses.

All statistical analyses were performed using SPSS version 23.0 statistical software (IBM Corp., 2015). Qualitative variables were described as frequencies and percentages, and quantitative variables were presented as mean and standard deviations (SD). The Pearson chi-square test was performed to determine the level of association among the dependent and independent categorical variables. Comparisons of the means of the quantitative variables between households' consuming and non-consuming goat milk and goat milk products were performed using the non-parametric test of *U* Mann–Whitney. A binary logistic regression analysis was then performed on a set of categorical and continuous variables to predict a household's consumption of goat milk and goat milk products. The logistic regression model makes it possible to predict the membership of a predefined class from a series of descriptors where the dependent variable is binary or dichotomous and can be 1 (group member), with a probability of success of P, or 0 (non-member), with a failure probability of 1-P. The relationship between the dependent and independent variables is not a linear function. Instead, the logistic regression function is used, which is the logit transformation of y:

$$Logit\left[y(x)\right] = \alpha + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_i x_i$$

Where,

α = the constant of the equation, and

β = the coefficient associated with the independent variable x (predictor)

The β coefficients indicate the relative effect of a particular predictor on the outcome (dependent variable). The larger the β coefficient, the more strongly its corresponding predictor contributes to the outcome. Its sign (positive or negative) indicates the direction of the relationship between the outcome and the corresponding predictor. Positive β coefficients indicate that the outcome becomes more likely as the predictor increases. Negative coefficients indicate that the outcome becomes less likely as the predictor increases.

In the logistic regression procedure used, the analysis begins with a complete model that includes all variables. Then, variables that are not useful for predicting the dependent variable are eliminated from the model. The analysis is completed when no variables can be eliminated from the model. Odds ratios for continuous predictors that are >1 indicate that the outcome is more likely to occur as the predictor increases. Odds ratios that are <1 indicate that the outcome is less likely to occur as the predictor increases. For categorical predictors with n levels of measurement, the odds ratio compares the odds of the event occurring at (n-1) levels of the predictor. Odds ratios >1 indicate that the event is more likely to occur and odds ratios >1 indicate that the event is less likely to occur. A thorough description of the binary logistic regression analysis method is provided in Hilbe (2009).

Statistical tests were two-tailed, and p-values <0.10 were considered statistically significant. We used this p-value cut-off because this study was prone to random errors (Thiese et al., 2016; Gichohi-Wainaina et al., 2022).

RESULTS

Socio-Economic Characteristics

The socio-economic characteristics of the surveyed households in Karimama are presented in **Table 1**. The heads of households were mainly (78.1%) men of 42 years old on average. Household sizes ranged between 6 and 10 persons. Three main socio-cultural groups cohabitated: *Dendi* (49.4%), *Peulh* (42.0%) and, *Gourmantché* (6.4%). Most of the surveyed households kept cattle (68.2%) and goats (55.9%).

Households keeping goats raised either the Sahelian goat (60.0%) or the Djallonké goat (40.2%). The average number of goats per herd ranged from 1 to 100, with an average value of 10 animals, mainly female (59.3%).

TABLE 1 | Socio-economic characteristics of households surveyed.

Variables	Frequency (%)
Gender of the head of household	
Female	21.9
Male	78.1
Age class of head of household	
<21	6.1
22–40	49.5
41–60	33.8
>60	10.5
The educational level of head of household	
None	58.0
Primary school	7.5
Secondary school	11.0
Tertiary school	2.8
Islamic school	16.6
Local language education	4.2
Household size	
1–5	40.3
6–10	37.4
11–15	14.6
>15	7.7
Socio-cultural group	
Dendi	49.4
Peulh	42.0
Gourmantché	6.4
Others	2.2
Livestock species kept	
No livestock	23.2
Goat only	8.6
Cattle only	20.9
Goat and cattle	47.3
Self-perceived household's financial status	
Poor	37.3
Modest	57.6
Rich	5.1

Goat Milk Consumption, Sources, and Forms

Of the 721 households surveyed, 106 (14.7%) declared that they consumed goat milk and its derivatives, of which 75 (70.8%) kept goats. The remaining 31 households were not keeping goats and obtained the consumed milk through gifts (79.3%) or purchases (20.7%).

Table 2 presents the origins and forms of consumed goat milk. Only 25.3% of surveyed goat-keeping households declared that they used to milk their goats and most (67.6%) of the goat milk collected was used for in-home consumption. It is worth noting that, in addition to milk obtained from their goat herds, 1.3% of goat milk-producing households reported that they also purchased the consumed goat milk from other producing households. The average price paid for one liter of goat milk was 500 FCFA (≃1$US), twice that of cow milk.

TABLE 2 | Origins and forms of consumed goat milk and milk products in Karimama, Niger Valley of Benin.

Variables	Total	Households keeping goats	Households not keeping goats	Chi^2	*P*-value
	(*n* = 106)	(*n* = 75)	(*n* = 31)		
	Frequency (%)				
Source*				96.865	0.000
Own goat herd	70.8	97.4	0.0		
Purchased	6.6	1.3	20.7		
Gifted	22.6	1.3	79.3		
Forms*					
Fresh milk	87.7	92.1	76.7	4.765	0.029
Fermented milk	28.3	19.7	50.0	9.708	0.002
Cheese	0.9	1.3	0.0	0.398	0.528
Yoghurt	1.9	0.0	6.7	5.164	0.023
Other	1.9	2.6	0.0	0.805	0.370

**Multiple responses were allowed.*

The main reason for consuming goat milk products, as mentioned by 84.0% of consuming respondents, was its benefits for health, followed by food habits (46.2%). In contrast, for 81.8% of non-consuming respondents, goat milk consumption was not a food habit.

Goat milk was generally consumed either fresh (87.7%) or fermented (28.3%), primarily because goat milk is usually insufficiently available (32.2% of the producing households), but also because the households lack the knowledge of goat cheese making (23.0% of the producing households).

Furthermore, the majority of consumers perceived goat milk as having a moderately pleasant taste (72.6% of respondents) and color (58.5% of respondents), and an intense odor (75.5% of respondents).

Socio-Economic Factors Determining Goat Milk Consumption

Table 3 relates the socio-economic characteristics of the households with their consumption or not of goat milk and milk products. Households' consumption of goat milk and milk products varied significantly ($P < 0.10$) according to their socio-cultural background, age class of the household head, goat breeding, and livestock species kept (**Table 3**). The results of the logistic regression presented in **Table 4** confirmed socio-cultural background and goat breeding as the main factors determining household consumption of goat milk and milk products. As shown in **Table 4**, the odds that a household consumes goat milk and milk products were 2.285 and 2.017 times higher, respectively, for households of *Dendi* ($p = 0.015$) and *Peulh* ($p = 0.041$) socio-cultural background, compared to others. **Table 4** also shows that the odds that a household that keeps goats will likely consume goat milk and its products is 2.155 times higher than households that do not keep goats. A test of the overall model against a constant-only model was statistically significant; indicating that the two predictors (household's socio-cultural

TABLE 3 | Relation between household's socio-economic characteristics and consumption of goat milk in Niger Valley of Benin ($n = 721$).

Variables	Consumption of goat milk and its products		Chi^2	*P*-value
	Yes	No		
	Frequency (%)			
Socio-cultural group			5.716	0.057
Dendi ($n = 356$)	42.5	50.6		
Peulh ($n = 303$)	43.4	41.8		
Gourmantché ($n = 62$)	14.2	7.6		
Age			10.151	0.017
<21	4.0	8.8		
22–40	48.6	50.6		
41–60	37.2	29.6		
>60	10.2	11.0		
Municipality (%)			0.481	0.488
Karimama ($n = 420$)	61.3	57.7		
Malanville ($n = 301$)	38.7	42.3		
Self-classification socio-economic status (%)			0.596	0.742
Poor ($n = 269$)	35.8	37.6		
Modest ($n = 415$)	57.5	57.6		
Rich ($n = 37$)	6.6	4.9		
Goat breeding (%)			11.131	0.001
Yes ($n = 403$)	70.8	53.3		
No ($n = 318$)	29.2	46.7		
Livestock species kept (%)			11.754	0.008
None ($n = 167$)	17.0	24.2		
Goat only ($n = 62$)	12.3	8.0		
Goats and Cattle ($n = 341$)	58.5	45.4		
Cattle only ($n = 151$)	12.3	22.4		
	Mean ± Standard deviation			
Age of head of household (years)	41.91 ± 13.07	41.59 ± 15.41		0.535

TABLE 4 | Logistic Regression predicting the likelihood of a household to consume goat milk in Niger Valley of Benin ($n = 721$).

Predictor	β	S.E of β	Wald's χ^2	df	*p*	e^{β}(odds ratio)
Constant	0.784	0.316	6.168	1	0.013	2.190
Socio-cultural group	N.A.	N.A.	5.935	2	0.051	N.A.
Dendi (1)	0.826	0.341	5.868	1	0.015	2.285
Peulh (2)	0.702	0.343	4.177	1	0.041	2.017
Goat breeding (1=yes)	0.768	0.231	11.019	1	0.001	2.155
Test			χ^2	df	*p*	
Overall model evaluation (Model χ^2)			16.931	3	0.001	
Goodness of fit test (Hosmer and Lemeshow)			1.791	4	0.774	
−2 Log Likelihood= 585.106						
Cox et Snell R^2= 0.023						
Nagelkerke R^2 = 0.041						

group and goat keeping) distinguished the goat milk consuming households from the non-consumers. The model correctly classified 85.3% of the households to their actual group.

DISCUSSION

The relatively high proportion (55.9%) of households keeping goats in the study area confirms the important role that plays goat keeping in the livelihoods of rural people in Benin and agrees with previous findings by Dossa et al. (2008). However, to our best knowledge, this study is the first to explore the perception of Beninese rural people toward goat milk consumption. As shown by the results, the likelihood of a household consuming goat milk was significantly influenced by the socio-cultural group of the head of the household and whether the household kept goats or not. The results of the logistic regression analysis confirmed the power of the two latter variables in predicting the household behavior toward goat milk consumption. Households from the *Dendi* socio-cultural background were more likely than others to consume goat milk and its products. As reported by the representatives of these households, goat milk was often used to feed the new-borns who lost their dams. Similarly, Olivier de Sardan et al. (1999) reported that, in Niger, people from the *Hausa* socio-cultural group, close to *Dendi*, were already feeding their new-borns with goat milk. In other socio-cultural groups present in the study area, namely the *Peulh*, there were still some barriers against goat milk consumption. Similar barriers were reported among the *Peulh* communities of the Ferlo in Senegal by Ka (2017). According to these authors, these communities perceived goat milk as a source of asymptomatic diseases and excluded it from their diet. But, in other Senegalese regions, other *Peulh* communities are known as the main producers of goat milk (Diouf, 2004). As mentioned by Oniang'o et al. (2003), socio-cultural beliefs and taboos significantly influence food habits, especially the choice and consumption of foods of animal origin, such as goat milk, in most African communities. Nevertheless, the findings of our study suggest that an improved adoption of goat milk and milk products by the rural people in the study area and beyond, irrespective of their socio-cultural group, might be expected once they are sensitized about their health and nutritional benefits.

Goat keeping by a household had also significantly determined whether the household will consume or not goat milk and its derivatives, showing that having goats in the household determines its availability, thus its consumption. Similar results were found in previous research where it had been found that respondents who owned 1 to 5 goats were associated with the likelihood of consuming goat milk (Mpofu et al., 2010). Güney (2019) also reported that goat milk availability is one of the most effective factors affecting its consumption and households' purchase behavior.

Other Socio-economic factors, such as the education level of the head of the household and the household's wealth status, have been noted to significantly influence the household's attitude

toward the consumption of goat milk and milk products (Guney and Ocak, 2013; Jerop et al., 2014). However, in our study, no significant differences in household head education level and household wealth status were observed between goat milk consuming and non-consuming households.

Households keeping goats claimed that the amount of milk produced in their goat herds was so far insufficient to satisfy both the new-born goat kids and their households' needs. This finding suggests that increasing the quantity of available goat milk at the household level by enhancing the herds' milk productivity could lead to improved households' goat milk consumption. This could be achieved through well-designed village goat breeding improvement programs. However, in addition to its insufficient availability, which is also reported in Morocco by Zine-eddine et al. (2021), the strong smell of goat milk, as perceived by most non-consumers, represented an important factor limiting its consumption. These results are similar to those reported by Guney and Ocak (2013) and Idamokoro et al. (2019) but contrast with those obtained by Jerop et al. (2014) in northern Kenya. The latter authors reported that the taste of raw goat milk positively influenced its consumption, but once processed, it was indistinguishable from that of cow milk. But a more recent study carried out in northern Kenya (Wanjekeche et al., 2016) found no significant differences between the palatability of raw goat and cow milk. Nonetheless, some respondents were already aware of the possibility of improving the smell of goat milk by using additives such as sugar and flavors. Regarding additives, a recent study (El-Shafei et al., 2020) has shown that the addition of water or permeate extract of quinoa to goat milk enhances its apparent viscosity, microstructure, and organoleptic acceptability. Locally available plant extracts commonly used as natural additives might exist and should be investigated. Improving the quality of goat milk also involves its transformation into derived products such as cheese. The use of natural culture microorganisms, such as *Leuconostoc lactis* (De Santis et al., 2019) or *Lactobacillus acidophilus* (Papaioannou et al., 2022), in the yogurt made with goat milk, can enhance its aromatic characteristics and acceptability.

The fact that goat milk was consumed in the study, even by children especially maternal orphan new-borns, mainly without any processing, represents a serious concern. According to Basnet et al. (2010), although goat milk is very nutritious and recommended for the growth of children, it should not be consumed in its unmodified form by children. These authors reported serious clinical cases associated with the consumption of raw goat milk by children. Razafindrakoto et al. (1993) advised to not include goat milk in the diets of children below 1 year because of the allergenic nature of milk for children who do not yet have a well-formed digestive system. It is therefore crucial to educate households on the need to not give raw goat milk to their children.

Several processing techniques, including pasteurization, could be used to improve the nutritional quality of goat milk and its derivative products. Pasteurization increases the digestibility of goat milk proteins (Chen et al., 2019; Tadjine et al., 2019), and reduce the risk of zoonotic disease transmission *via* the consumption of raw milk and its cheese (Nayik et al., 2021; Pappa et al., 2022). Furthermore, Tadjine et al. (2019) reported a higher cheese yield with pasteurized goat milk.

Limitations of the Study

Perception studies require focus group discussions, as it allows to compare results from individual interview surveys with the judgments of groups of stakeholders from various profiles. In Focus groups, people of similar socio-economic conditions are gathered together and encouraged to talk to one another, to comment on each experiences and points of view (Kitzinger, 1995). Hence, a focus group would have enabled a better understanding of the social and cultural beliefs around goat milk consumption among the *Dendi* people, the most represented socio-cultural group in the municipalities of Karimama and Malanville. Furthermore, it would have allowed us to better explain the positive attitude of younger heads of the household toward goat milk. This is an exploratory study that deserves to be deepened.

Implications for the Development of a Smallholder Dairy Goat-Breeding Program

The evaluation of households' perception, especially those keeping goats, their attitude toward goat milk, and the factors which influence them would make it possible to determine the appropriate breeding strategies and policies for improving village goat farming systems in the Niger Valley of Benin and similar production areas. In this study, apart from the socio-cultural origin and whether the households kept goats or not, the factor that most influenced the consumption of goat milk was its perceived health benefits. Improving households' knowledge of its nutritive values and awareness of its health benefits could represent a good entry point for increasing its acceptance and consumption by rural people. The existence of goat milk consumers in the study area, although limited, combined with its low availability and high nutritive values suggests that opportunities do exist for developing niche markets for goat milk.

Idachaba (2000) and Anaeto et al. (2010) summarize the advantages of goat keeping; according to them, goats are "walking factories" producing food for humans as they graze on pastures and eat farm by-products, thus reducing the costs of weeding and feeding. They state that goats can use feed that is difficult to consume for cattle; keeping them provides a source of income and protein for the family faster than cows due to their short generation interval. These elements make the dairy goat value chain a sector with very high economic and nutritional potential for rural households, especially those with few resources.

It is expected that by raising awareness among rural households about the health benefits of goat milk consumption and enhancing goat herds' milk productivity through sound and participatory village-based goat dairy programs, both the demand for and supply of goat milk will increase. Such development initiatives have been successfully implemented in Kenya (Ahuya et al., 2005; Ogola et al., 2010), Tanzania, and Malawi (Lie et al., 2012; Nandolo et al., 2016; Ketto et al., 2020). In Benin, the government, through the West African Agricultural Productivity Program (WAAPP), introduced 2016 Maradi goats from Niger

into several municipalities in the North of the country, including Karimama and Malanville in the Niger Valley of Benin. Maradi goats are known to be good milk animals (Adebambo et al., 2011). But, the objective of its introduction was to improve the meat productivity of the endemic breeds in these locations by long-term interbreeding, not for milk production. This program should have rather been the ideal springboard to inform the population about the good dairy aptitudes of the red Maradi and establish the basis for its use in a dairy goat breeding program. Pure exotic or cross-bred dairy goats and associated technologies are preferred as a rapid means of improving both the animal productivity and livelihoods of smallholder goat farmers (Kosgey et al., 2006). But their adaptation to local climatic and environmental conditions could be a problem. The advantage of using the Red Maradi goat for upgrading the local goats of Benin is its geographical origin, as Maradi shares many environmental similarities with the Niger Valley of Benin, thus favoring its adaptability. Nevertheless, the success and sustainability of any breeding and selection programs for dairy goats would depend on farmers' readiness to adopt improved management practices.

CONCLUSION AND RECOMMENDATIONS

The study aimed to collect the various perceptions of the populations of the Niger Valley of Benin on the consumption of goat's milk and its by-products on the one hand and to determine the factors that influenced this consumption on the other. This study determined that overall, goat milk consumption was low in this region. It was established that the lack of goat milk consumption habit, its repulsive sensory attributes and limited availability were obstacles to its consumption. It was also determined that the factors that influenced the consumption of this milk were the household's socio-cultural background and goat rearing by the household. Indeed, *Dendi* and *Peulh* households rearing goats had a higher propensity to consume goat milk and its derivative products. To diversify the products of goat farming in the two municipalities and to participate in the improvement of household food security, it is recommended that the population of Karimama and Malanville should be more sensitized and informed about goat milk and the benefits of its consumption. We also encourage the gradual establishment of a dairy goat value chain. The establishment of such a project is ideal given the presence of dairy goats in the region. The objective of such a project is to improve both the nutritional and economic conditions of rural households by using animals that can provide a good protein supply and a source of income for smallholders.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/**Supplementary Material**, further inquiries can be directed to the corresponding author/s.

AUTHOR CONTRIBUTIONS

K-LI, CM, AA, and LD designed the study. K-LI and O'fB collected the data. K-LI, MA, and LD performed statistical analyses and drafted the manuscript. MA, CM, AA, and LD reviewed and edited the manuscript. All authors contributed to the article and approved the submitted version.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fsufs.2022.901293/full#supplementary-material

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