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RESEARCH ARTICLE **ARAŞTIRMA MAKALESİ**

Contribution of African indigenous plants to human and animal nutrition security: Insight from the use of baobab in Northwestern Nigeria

Afrika yerli bitkilerinin insan ve hayvan beslenme güvenliğine katkısı: Kuzeybatı Nijerya'da baobab kullanımından içgörü

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ABSTRACT

In this study, we looked into how the baobab, an indigenous plant of Africa, affected households of Hausa-Fulani in Northwestern Nigeria's nutrition security. The study employed a mixed data set from 239 households. Specifically, we looked at how baobab contributed to the nutritional security of children under the age of five and how baobab was used to manage livestock. We also described the features of Hausa-Fulani families in Northwestern Nigeria. The data were analyzed using multinomial regression models and descriptive statistics. The Focus Group Discussion showed that baobab enhances a child's nutritional status. The multinomial regression analysis supported this since baobab consumption was found to positively influence weight gain. Numerous ethnoveterinary functions of baobab were also reported. It was concluded that baobab contributes significantly to the nutritional security of households in the study area. We thus urge the use of baobab for food bio-fortification and the necessity for research to boost the indigenous food systems of Africa. The result of this study will help encourage the utilization of baobab plant parts in the fortification of diets and strengthen the value chain system of the plant.

ÖZET

Bu çalışmada, Afrika'nın yerli bir bitkisi olan baobab'ın, Kuzeybatı Nijerya da yer alan Hausa-Fulani'de yaşayan hane halklarının beslenme güvenliğini nasıl etkilediği incelenmiştir. Çalışmada 239 haneden elde edilen karma veri seti kullanılmıştır. Çalışmada özellikle, baobab'ın beş yaşın altındaki çocukların beslenme güvenliğine nasıl katkıda bulunduğu ve baobabın çiftlik hayvanlarını yönetmek için nasıl kullanıldığı incelenmiştir. Hausa-Fulani ailelerinin özelliklerinin de incelendiği çalışmada, veriler, çok terimli regresyon modelleri ve tanımlayıcı istatistikler kullanılarak analiz edilmiştir. Odak Grup toplantılarından elde edilen bilgiler, baobab'ın çocukların beslenme durumunu iyileştirdiği tespit edilirken, çok terimli regresyon analiz sonuçlarına göre, Baobab tüketiminin kilo alımını olumlu yönde etkilediği belirlenmiştir. Baobabın çok sayıda etno-veteriner işlevi rapor edilirken, Baobab'ın araştırma alanındaki hanelerin beslenme güvenliğine önemli katkı sağladığı sonucuna varılmıştır. Bu nedenle, gıda biyo-zenginleştirmesi için baobab kullanımı ve Afrika'nın yerel gıda sistemlerini desteklemek için bu bitkinin daha fazla araştırılması gerektiği sonucuna ulaşılmıştır. Bu çalışmadan elde edilen sonuçlar, baobab bitkisi parçalarının diyetlerin zenginleştirilmesinde kullanılmasını teşvik etmeye ve bitkinin değer zinciri sistemini güçlendirmeye yardımcı olacaktır.

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INTRODUCTION

By 2050, the world's population is expected to exceed 10 billion, which means that malnutrition will affect more people due to both calorie shortage (hunger) and surplus (obesity) (Niyaz, 2016; Abarca-Gómez et al., 2017; FAO, 2019). The main causes of food and nutrition insecurity, particularly in developing nations, are the growing world population and other factors like deforestation and climate change (Bvenura & Sivakumar, 2017; Narjes & Lippert, 2019). This makes it essential to provide a sustainable food system and a healthy diet to the growing global population. As the human population, urbanization, and climate unpredictability grow exponentially and exacerbate food insecurity in regions that are already vulnerable to hunger and malnutrition, serious concerns have been expressed about the rising global hunger (Wheeler & Von Braun, 2013; Willett et al., 2019).

In 2020, there were 821 million individuals who were undernourished in the world or one in every nine people (Fouberg et al., 2020). Additionally, over 2 million people worldwide suffer from hidden hunger, which is a significant part of food poverty and is defined by micronutrient deficiencies (Fortin, 2018; WHO, 2017). This component of food insecurity has severe negative effects on a child's survival rate especially in the early years of life with significant physical and cognitive consequences (Britto et al., 2017; Mngadi et al., 2019). In addition to being unhealthy, unrecognized hunger can impede socio-economic advancement (Von Grebmer et al., 2014). Therefore, it is crucial to explore the potential of local plants as valuable food sources in addition to fostering socio-economic development and bettering living conditions (Omotayo & Aremu, 2020).

Rising reliance on arable crops as a food source has been linked to worsen nutrition particularly in developing countries. Tanimonure (2021) asserts that the household food consumption habits of developing countries are monotonous and rely mostly on a small number of carbohydrates like yam, maize, and rice, which are thought to be less expensive than diets high in essential micronutrients. Because many people in rural areas are poor and unable to purchase healthful meals, vegetables and proteins, which are rich providers of micronutrients, are often less in demand in these areas (Ogechi & Chilezi, 2021).

When it comes to research, application, and value addition, many indigenous African plants have not gotten enough attention. In Padulosi et al. (2002) and Li & Siddique (2018), the indigenous crops were labeled as "traditional," "minor," "underdeveloped," "underexploited," "lost," "alternative," "local," "orphan," "niche," "promising," "novel," and "hidden treasures" owing to their marginalization by researchers, policymakers, and modern farming methods. These crops have been disregarded because of their unrealized potential and ineffective competition with other significant crops. They are either grown naturally or mostly by neighborhood farmers who use age-old techniques and little to no agricultural extension or modern technology.

There are numerous underutilized indigenous plants including grains, pulses, nuts, root crops, and horticulture crops. It is unknown how many underutilized native plants can be utilized to provide food for humans. Currently, there are a number of reports with differing plant counts from 5538 (Royal Botanic Gardens Kew, 2016) to 75000 (Wilson, 1988). Researchers, nutritionists, practitioners of the food value chain, and practitioners of the conservation of plant diversity are all putting in a lot of effort to spread awareness of the value of indigenous underutilized crops and their integration into the current agricultural food production systems in the twenty-first century (Padulosi et al., 2002).

Studies have shown that underutilized indigenous plants play a significant role in the food and nutrition security of rural households (Van-Huis, 2013). There is a dearth of empirical evidence on their production rate, consumption rate, and pattern as well as their processing. African indigenous plants have weak value chains and are governed by weak value policies (Li & Siddique, 2018). It is against this backdrop that this study seeks to fill the identified research gaps by specifically focusing on baobab.

The baobab tree (*Adansonia digitata* L.) can be found In sub-Saharan Africa's driest region. As almost every component of the plant is advantageous to both humans and animals, the baobab tree is frequently referred to as

a superfruit. Through the generation of money, the tree can directly or indirectly improve family nutrition and food security. Employed in the process are the bark, leaves, fruit, and trunk. The fruit of the baobab is consumed raw or transformed into the Nigerian yogurt beverage known as "Kunnu," while its bark, leaves, and rope are used to produce bags, clothing, and sauces. Abasola (2013).

A. digitata, it is a giant deciduous tree with a life expectancy of up to 450 years that may reach heights of 20 to 30 m (m), a monstrous girth of 20 to 35.10 m, and a diameter that ranges from 14.3 to 32.0 m (Patrut et al., 2018). The African baobab fruit, often known as the "Queen of superfruits," is rich in vitamins, minerals, and has a number of other special health advantages. The seed is a good source of potassium (K), phosphorus (P), glucose, and vitamin C. All the eight (8) essential amino acids are present in the African baobab fruit, making it a good supply of amino acids (Namratha and Sahithi, 2015).

This study explores the role the baobab plant plays in the food and nutrition security of rural households in northwestern Nigeria. Specifically, this study focused on the socio-economic traits of Hausa-Fulani households in North-Western Nigeria and the role of baobab in the management of livestock among rural households in the study area. The study also analyzed the contribution of baobab to the nutritional security of children under the age of five.

MATERIALS and METHODS

The study area

This study was conducted in the states of Kano and Jigawa in Nigeria's northwest geopolitical zone. These two states were included in the study because the baobab plant is abundant in both of them based on the report of the key informants during the preliminary survey.

Sampling technique

Three stages of sampling were used to choose the respondents for this survey. Stage one consists of the purposeful selection of Jigawa and Kano States from Nigeria's northwest geopolitical zone. Due to the abundance of baobabs and the presence of households that consume, process, and market baobabs, these two States were specifically chosen. This decision was based on the advice from significant informants who reside in Northwestern Nigeria. In order to acquire substantial data for this exploratory inquiry, communities were selected from each of the three senatorial districts in both states.

In the second stage, each of the three senatorial zones in each State had two (2) communities chosen at random. Therefore, six (6) localities were chosen at random from each state for a total of 12 communities in the study. They were chosen to be a fixed number of households in each community. 20 baobab-consuming and processing households were therefore chosen. This is due to the fact that during the survey time, the researchers were not in possession of the list of communities in each senatorial district. Consequently, 240 houses in all were chosen for the study.

As stated in Table 1, a total of 310 children were drawn from the chosen households. Children under the age of five who make up no more than three of the household were chosen. The respondent is questioned about whether any of the chosen households had kids under the age of five. If so, permission is requested before measuring the children in this age range using anthropometry. Anthropometric measurements were carried out on a family's three children (Figure 1).

Table 1. Sampled children in the study
Çizelge 1. Çalışmada örnek alınan çocuklar

Category	Number of children	Total number of selected children
Household with at least one child under the age of five years (child 1)	153	
Households with at least two children below the age of five years (child 2)	114	**310**
Households with three children below the age of five (child 3)	43	

Figure 1. Anthropometry measurement of a child in Jigawa State
Şekil 1. Jigawa eyaletindeki bir çocuğun antropometri ölçümü

Data collection

For the purpose of gathering both quantitative and qualitative data sets, this study used a mixed technique of collecting data that included a semi-structured interview schedule, anthropometric measurements and focus group discussions. Data collection was carried out for 5 cumulative weeks between 7th of February to 15th of March, 2019. The target respondents for this study were the persons responsible for food and nutrition decision as well as children who are five years and below in each household.

Quantitative data collection

The Kobo toolkit was used in this study to collect quantitative data in order to effectively monitor the enumerators and ensure the accuracy of the data. The creation of this form in the Kobo toolbox included the use of a consent page stating that informed consent has been given, GPS capture of home coordinates, camera images, socio-economic data, the Household Food Insecurity Access Scale Module, consumption, processing, and marketing of baobab, multidimensional use of baobab, and anthropometric measurements such as upper arm circumference, weight in kg and height in centimeters.

Qualitative data collection

To gather qualitative data from the respondents, the Focused Group Discussion (FGD) method was used. In order to fully comprehend how Hausa-Fulani people in western Nigeria used baobab for social, cultural, and dietary objectives, Focus Group Discussions (FGD) were held. It was conducted to gain more understanding of the indigenous wisdom of the area and the role of baobab in the management of cattle.

One FGD was conducted for each sampled community the men who were the major informants in each community. A total of 12 FGDs were conducted in the research area. The FGD includes inquiries regarding baobab use in child care, managing livestock, and bio-fortification. It was possible to record the FGD via audio recording, video clips, or note-taking. The outcomes of FGDs were then documented for debate. Table 2 contains details on the FGD discussants in the research area.

Table 2. Focus group discussion participants of the study
Çizelge 2. Çalışmanın Odak grup tartışması katılımcıları

State	District	LGA	Community	No of Discussants	Total
Jigawa	Jigawa southwest	Miga	Dunnaka		
			Sabo Garin Takanebo	11	
	Jigawa north west	Taura	Gurjawa, Yangayami	10	
				14	
	Jigawa north east	Kaugama	YalonMaikasuwa,	8	
			kukyar	7	
Kano	Kano Central	Ungogo	Rijiyar Zaki	15	**142**
			Dausayi	8	
	Kano North	Tofa	Janguza,	14	
			Dansudu	6	
	Kano South	Wudil	Wudil,	28	
			Zaki	21	

LGA: Local Government Area

Data analysis

Along with multinomial regression analysis, descriptive statistics including frequency distribution, percentages, and bar charts were used to analyse the acquired data.

Descriptive statistics

The socio-economic characteristics of the selected children under the age of five and the role of the baobab plant in Fulani cattle management in the research region were both described using this data.

Z-Score computation and multinomial regression analysis

To assess the effect of baobab consumption on the nutritional status of Fulani children under the age of five in the study area, the Z-scores were calculated using the following formula (Martinez-Millana et al., 2018):

$$\mathrm{Z} = \frac{X - \mu}{\sigma}$$

where:

X= observed value

μ= population mean

σ = population standard deviation

$$\boldsymbol{y} = \mathrm{Z} - \mathrm{score} = \begin{cases} 1 = under\ weight \\ 2 = normal\ \ weight \\ 3 = over\ \ \ weight \\ 4 = obesity \end{cases}$$

Child Malnutrition Status= $F(X_1+X_2+X_3+X_4+X_5+X_6+X_7+X_8+X_9+X_{10}+X_{11}+X_{12})$

$\boldsymbol{x_1}$ = age of household head (yrs)

$\boldsymbol{x_2}$ = year of schooling
$\boldsymbol{x_3}$ = monthly income from pastoralism Naira (₦)
$\boldsymbol{x_4}$ = household size
$\boldsymbol{x_5}$ = farm size (ha)
$\boldsymbol{x_6}$ = food expenditure Naira (₦)
$\boldsymbol{x_7}$ = quantity of baobab consumed (kg)
$\boldsymbol{x_8}$ = weekly frequency of baobab consumption
$\boldsymbol{x_9}$ = herd size
$\boldsymbol{x_{10}}$ = income from baobab
$\boldsymbol{x_{11}}$ = gender of the child = $\begin{cases}1 = Male \\ 2 = Female\end{cases}$
$\boldsymbol{x_{12}}$ = age of the child

The outputs had three equations since the response variable had four categories and category 2 (normal weight) was used as a baseline or reference category. Hence the first equation is given as follows:

$$\log\left(\frac{P(Zscore=1)}{P(Zscore=2)}\right) = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \ldots + \beta_{11}(x_{11}=2) + \beta_{12} x_{12} \quad (1)$$

$$\log\left(\frac{P(Zscore=3)}{P(Zscore=2)}\right) = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \ldots + \beta_{11}(x_{11}=2) + \beta_{12} x_{12} \quad (2)$$

$$\log\left(\frac{P(Zscore=4)}{P(Zscore=2)}\right) = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \ldots + \beta_{11}(x_{11}=2) + \beta_{12} x_{12} \quad (3)$$

$$\log\left(\frac{P(Zscore=4)}{P(Zscore=2)}\right) = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \ldots + \beta_{11}(x_{11}=2) + \beta_{12} x_{12} \quad (3)$$

Thus, if the multinomial regression model generated significant relationships on any of the two proxy variables, the study will conclude that baobab activities contributed significantly to the nutritional status of the Fulani children under the age of five years.

RESULTS and DISCUSSIONS

This section includes details on the socio-economic characteristics of Hausa-Fulani households, socio-economic characteristics of children underfive years living in the study area, the FGD report, the effects of baobab consumption on child nutrition, the role of baobab in cattle management as well as the coping strategies employed by selected households in the event of food shocks.

Socio-economic characteristics of the Hausa-Fulani Households of North western Nigeria

Details on the socio-economic characteristics of the homes are shown in Table 3. Averaging 46 years old, with a majority of men (57%) and 3.5 years of schooling, the responders were mostly male. They were 46 years old on average with a household size of 9. Over half of the respondents (58.58%) reported having no formal education. The typical farm had 2.89 ha in size and generates ₦ 40,790 monthly on average.

Table 3. Socio-economic characteristics of the households included in the study
Çizelge 3. Araştırmaya dahil edilen hanelerin sosyo-ekonomik özellikleri

VARIABLE	CATEGORY	(n=239)			
		Freq.	Percent	Mean	SD
Age of the respondents	20-29	25	10.5		
	30-39	54	22.6		
	40-49	62	26.0	45.7	13.2
	50-59	63	26.4		
	>60	35	14.6		
Gender of the respondents	Male	137	57.3		
	Female	102	42.7		
Years of schooling	0	140	58.6		
of the respondents	1-6	66	27.6		
	7-12	23	9.6	3.5	4.8
	13+	10	4.2		
Age of Household Head	20-29	1	0.4		
Head (HH)	30-39	24	10.0		
	40-49	52	21.7	54.5	3.5
	50-59	93	38.9		
	60 &above	69	28.8		
Marital status of HHH	Married	221	92.5		
	Widowed	13	5.7		
	Divorced/separated	5	2.1		
Household size	<10	117	48.9	9	2.3
	11-20	91	38.1		
	21-30	21	8.8		
	>30	10	4.2		
Educational status of the	No formal edu	137	58.6		
respondent	Primary	60	27.6		
	Secondary	29	9.6		
	Tertiary	13	4.2		
Farm size (ha)	None	32	13.4	2.89	3.9
	<1-5	181	75.7		
	6-10	16	6.7		
	11-15	7	2.9		
	>15	3	1.2		
Total monthly income (₦)	0-50,000	165	69.0	40,790.79	61235.2
	50,001-100,000	54	22.6		
	100,001-150,000	8	3.3		
	150,001-200,000	3	1.3		
	200,001-250,000	3	1.3		
	250,001-300000	6	2.5		

Utilization and marketing of baobab in the study area

Table 4 details the baobab harvesting, marketing, consumption, and management patterns in the research area. 97.9% of the families (households) do not participate in the export of baobab. Most of the households thought that the leaves of the baobab plant were the most important part contrary to what Chadare et al. (2008a,b) discovered

in their 2010 study "Baobab foods from Benin: composition, processing, and quality" which revealed that the baobab tree's pulp was regarded as the most important part of the tree in the Republic of Benin. In spite of the fact that baobab is a substantial export crop in East Africa, South Africa, and Europe, only 2.1% of the families in the study region exported baobab. The results thus provide additional evidence that baobab is underutilized in Nigeria. In other wealthy nations, the baobab fruit's chaff is used to produce bags (Asogwa et al., 2020) but in the research region, it is only converted into a local sponge that is frequently used at homes. In Eastern Africa, the baobab seed is processed to make baobab seed oil (Asogwa et al., 2020) but in the research region, the baobab seed is solely processed to make a traditional condiment called *dawa dawa.*

Table 4. Baobab harvesting, consumption, marketing and management in the study area
Çizelge 4. Çalışma alanında baobab hasadı, tüketimi, pazarlaması ve yönetimi

Variable	Category	Frequency	Percentage
Exporting of Baobab parts	No	234	97.9
	Yes	5	2.1
Baobab part of utmost importance to the HH	Baobab fruits	7	2.9
	Baobab leaves	224	93.7
	Baobab bark	8	3.3
The perceived population growth rate of baobab	Increasing	112	46.9
	Decreasing	80	33.5
	Stable	35	14.6
	Unaware	12	5.0
Adopted baobab conservation practices	Protect tree on cropland	64	26.8
	Fencing of seedlings	32	13.4
	A specialized method of harvesting	27	11.3
	Planting new trees	45	18.8
	Others	1	0.4
	No protection at all	152	63.6
Income from marketing baobab parts and products	0-50,000	237	99.2
	50,001+	2	0.8
Number of days in a week HH consume baobab	0	6	2.5
	1	5	2.1
	2	9	3.8
	3	37	15.5
	4	27	11.3
	5	52	21.8
	6	11	4.6
	7	92	36.5
Source of Baobab parts	Individual claimed trees	106	44.4
	Communal forest	47	19.7
	Market purchase	86	36.0
Weekly consumption of baobab leaves *(Kuka)* (kg)	0	52	21.7
	0.1-5.0	147	61.5
	5.01-10.0	36	15.1
	10.01+	4	1.7

Effect of baobab consumption on the nutritional status of children below the age of 5 years

The nutritional status of the children in the study region is described in Table 5 . The weight of the children ranges as underweight (41.29), normal (19.68%), overweight (20%), and obese (19.02%). This conclusionis consistent with Thomas and Eforuoku's findings from their study on food insecurity and nutritional condition of agricultural households in Northwestern Nigeria which was conducted in 2020. Their report states that the rate of overweight and obese children was 19.5% and 11.6%, respectively. However, the anthropometry measurement results contradict the respondents' claim that 74.6% of the sampled homes experienced food insecurity without hunger because more than half (41.29%) of the children in the study area were underweight.

Table 5. Nutritional status of the children in the study area

Çizelge 5. Araştırma alanındaki çocukların beslenme durumları

Variable	Category	Frequency	Percentage
Nutritional status	Underweight	128	41.3
	Normal weight	61	19.7
	Overweight	62	20.0
	Obesity	59	19.0
	Total	**310**	**100.00**

Multinomial logistic regression

The data of the first child in each household under the age of five years was used to analyze the multinomial regression for computational simplicity. Appropriate model testing was done, the data passed normality test and there was no multicollinearity problem. Different models with covariate or regressor interactions were constructed but there was no significant interaction. After that, inconsequential variables were gradually eliminated using the backward elimination method to arrive at the final result in Table 6. It should be noted that the model fits much better than a model with no predictor as indicated by the likelihood ratio chi-square (LR chi2) of 48.79 and a p-value of less than 0.001. Out of the three equations in the output, four variables had p values that fell below the 5% and/or 10% significance level (=0.05 or 0.10) indicating that they were statistically significant.

One explanatory variable (monthly food expenditure), with p-values less than 5% significant threshold (=0.05), was statistically significant for the first group (underweight). At a 5% level of significance, a one-unit increase in food spending was linked to 0.0001 reductions in the relative log odds of being underweight compared to normal weight. Two explanatory variables (amount of baobab consumed and frequency of baobab intake) for the second equation (overweight) were statistically significant, that is, they had p-values less than 10% significance levels (=0.10). Therefore, at a 10% level of significance, one unit increase in baobab consumption is linked to a 0.0508 increase in the relative log odds of being overweight compared to normal weight. Similar to this, at a 5% significant level, a unit increase in baobab consumption per week is linked to a 0.3284 decrease in the relative log odds of being overweight compared to normal weight.

Two explanatory variables (child's age and frequency of baobab use) were statistically significant at the 5% level for the third equation (obesity), which means that their p-values were less than the 5% significant levels (=0.05). Therefore, at a 5% level of significance, one unit increase in the child's age is linked to a 0.7398 rise in the relative log odds of being obese compared to normal weight. Additionally, at a 5% significance level, one unit of baobab consumption is linked to a 0.3204 reduction in the relative log odds of being obese compared to normal weight.

Table 6. Multinomial logistic regression results of determinants of the nutritional status of children below age five (child 1)

Çizelge 6. Beş yaşın altındaki çocukların (çocuk 1) beslenme durumunun belirleyicilerinin çok terimli lojistik regresyon sonuçları

z- score	Variables	Coeff.	S.E	Z	p- value
	Monthly food expenditure	-0.0001***	0.0000	-3.175	0.0015
	Qty. of baobab consumed	-0.0195	0.0385	-0.507	0.6118
Underweight	Freq. of baobab comsptn/wk	0.0931	0.1355	0.068	0.4921
	Age HHH*Gender	-0.7317	0.4614	-1.586	0.1128
	Age of the child	-0.0682	0.2065	-0.330	0.7411
	Constant	-0.555	1.2019	0.462	0.6440
	Monthly Food expenditure	-0.0000	0.0000	-0.321	0.7485
	Qty. of baobab consumed	0.0508*	0.0280	1.813	0.0699
Overweight	Freq. of baobab comsptn/wk	-0.3284**	0.1471	-2.232	0.0256
	Age HHH*Gender	0.5142	0.6230	0.825	0.4092
	Age of the child	0.2375	0.2872	0.827	0.4083
	Constant	-1.4716	1.4008	-1.051	0.2935
	Monthly Food expenditure	-0.0000	0.0000	-0.536	0.5921
	Qty. of baobab consumed	0.0434	0.0445	1.363	0.1728
Obese	Freq. of baobab comsptn/wk	-0.3204**	0.1826	-2.033	0.0420
	Age HHH*Gender	0.7305	0.6553	-1.336	0.1814
	Age of the child	0.7398**	0.4710	2.006	0.0449
	Constant	-4.3896	2.6230	-1.618	0.1056

NB: *: implies significant at 10%; **: implies significant at 5%; ***: implies 9999999999999944significant at 1%.

Multinomial logistic regression; Number of obs= 153 LR chi^2(15)= 48.79, Prob > chi2 = 0.0000, Log-likelihood = -156.18516, Pseudo R2=0.1351.

Focus group discussions

The focus group discussion participants reported that baobab products help young children grow and develop better because they provide essential nutrients to them. Baobab products can improve their bones and muscles by consuming the leaves as traditional vegetables cuisine called *"miyan kuka"*. As it provides them with vitamin A, it also helps to improve their vision. Baobab specifically treats stomach aches and prevents diarrhoea, improve the child's nutritional state, and brightens the child's vision.

Baobab stems, fruit pulp, and leaves are all used to make yoghurt, soup, and medicinal herbs, respectively. The following Hauas-Fulani native foods are bio-fortified with baobab leaves and pulp: *Akamu, Kunu, Danwake, Tuwo Shinkafa, Tuwo Dawa, Tuwo Masara,* etc.

The focus group participants also remarked that, in addition to being utilized as to bio-fortify children's diets, the baobab tree serves a number of additional nutritional purposes. For instance, the pulp of the baobab fruit is mixed with milk and given to young women for a few weeks before her wedding to boost their fertility. In order to encourage rapid weight gain, premature infants are often bathed in a herbal solution derived from baobab bark. Several herbal anti-diabetic and anti-hypertensive drugs are also made from ground-up, dried baobab barks.

It is important to note that some of the assertions made by the Hausa-Fulanis have been supported by laboratory research on the nutritional composition of baobab. The leaves are a good source of lipids, vitamins, amino acids, carbohydrates, and other nutrients according to some previous studies (Shukla et al., 2001). They are also a large supplier of minerals like iron, manganese, copper, and zinc. Additionally, they contain significant amounts of fiber, nitrogen, ash, and crude protein. According to Zahra'u et al. (2014), the essential components included in this plant are crucial for antioxidant activity, infection resistance, and electrolyte balance all of which affect the nutritional status of the consumers.

Role of baobab in cattle management

The participants in the focus groups also revealed how important baobab was for managing livestock. For instance, young calves are fed with baobab leaves to get rid of intestinal worms. The baobab leaves is said to contain some active ingredients that help to expel intestinal worms when given to young calves. Baobab leaves may also be consumed by pregnant cows with slower labor to hasten the labor and the birth.The focus group discussant also highlighted the fact that in cases of prolonged labor in a female animal, the cattle herd carer usually gives the aminal in labor the baobab leaves extract orally to speed up the delivery process. The peel from the baobab bark is needed to make ropes for binding young calves. Glycosides are deposited in the flora of the gut where they may help animals by, among other things, decreasing cholesterol (Zhabinskii, et al., 2015). Steroids may similarly lower cholesterol in mammals similar to how they have been linked to decreasing cholesterol (Zhabinskii, et al.,2015). Additionally, saponins have been found to have anti-bacterial, anti-inflammatory, anti-oxidant, and immune-stimulating properties in contrast to the strong antioxidant properties of carotene, vitamin C, and flavonoids.

In conclusion, the study revealed that baobab is very important for livestock management. Specifically, the concoction made from bark of the baobab tree is used as worm expellant in worm infested cattle. Baobab leaves are highly relished by sheep and cow. The baobab leaves extact is used for the induction of a cow in labour. In addition, the ropes made from the tree bark are used for tying livestocks.

The role of baobab in children's nutrition in the study region cannot be overemphasized. Consuming baobab helps lower the likelihood of childhood malnutrition in the study location. The most common coping mechanism used by Hausa-Fulani households in the study area to deal with their food insecurity is the selling of household possessions. The gathering and consumption of wild foods supports this information.

As a result, the study findings suggests that food and nutrition programs should promote the use of baobab pulp and leaves for food bio-fortification particularly in the diet of young children.

STATEMENT OF CONFLICT OF INTEREST

The authors declare no conflict of interest for this study.

AUTHOR'S CONTRIBUTIONS

The contribution of the authors is equal.

STATEMENT OF ETHICS CONSENT

The University of Ilorin ethical review committee granted the ethical approval for this study (ethical approval number: UERC/ASN/2019/1633).

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