

Food Habits of the Helmeted Guineafowl (*Numida meleagris* Linnaeus, 1758) in the Derived Savanna of Ofaji, Kogi State, Nigeria

Peter, W. I., Tanko, D. and Adang, K. L.

Department of Biological Sciences, Federal University Lokoja, Kogi State, Nigeria.
Corresponding Author Email: willpeterson889@gmail.com

Direct Research Journal of Biology and Biotechnology



Vol. 12(1), Pp. 13-22, March 2026,

Author(s) retains the copyright of this article

This article is published under the terms of the
Creative Commons Attribution License 4.0.

<https://journals.directresearchpublisher.org/index.php/drjbb>; <https://www.ajol.info/index.php/djbb>

Research Article
ISSN: 2734-2158

Received 18 January 2026, Accepted 7 March 2026, Published 15 March 2026

ABSTRACT

Maximizing the ecological, nutritional and economic benefits of Helmeted Guineafowl hinges greatly on general conservation and improved domestication of the species. Since the bird is not migratory, its survival or fitness is based on the resilience in adapting to any given environment. So, understanding the site-specific requirements of the bird is fundamentally essential. Information on the natural food habits of the bird in Ofaji vegetation is not available. Thus, the objectives of this study were to identify plant and animal diets of *N. meleagris* and to deduce its food preferences on the bases of sex, age and periods of the year. Ofaji is located on Latitude 7.61° 87'45" North of the equator, and longitude 6.98° 50'91" East of the Greenwich meridian. The study was based on the hypotheses that there are no significant differences in the food habits of the bird on the bases of age, sex and seasons respectively. Collection of the bird commenced on January 5, 2022 using instant kill by local gunshot. 35 birds were collected during the off-farming period, while 32 birds were collected during the farming period. Food items recovered from the gut of the bird included earthworm, 17 different arthropods and assorted parts of 24 plant species as tabulated. Percentage frequency was used to deduce food preference, while independent samples t-test ($P < 0.05$) was used to determine differences in the food habits of the bird on the bases of sex, age and seasons. It was found that *N. meleagris* has euryphagic food habits, feeding on both wild and cultivated plants along with arthropods and other small organisms. Consumption of animal food items was significantly higher in immature birds than in matured birds ($t = 2.293$, $p = 0.028$). Helmeted Guineafowl farmers should feed their birds with the identified natural food items.

Keywords: Food habits, Helmeted Guineafowl, Derived savanna, euryphagic, Nigeria

INTRODUCTION

The Helmeted Guineafowl (*N. meleagris*, Linnaeus 1758) is of great value to man and the environment. Endemic to Africa, but has become adapted to many ecological zones across the world. The bird belongs to the Class: Aves, Order: Galiformes, Family: Numididae, Sub-family:

Numidinae, Genus: *Numida*, Species: *Numida meleagris*. About ten subspecies are presently known (Moreno, 2026). The Helmeted Guineafowl, though not immune, but are quite resistant to some poultry diseases and requires little care to raise. The breeding of local Guineafowls (*N.*



Citation: Peter, W. I., Tanko, D. and Adang, K. L. (2026). Food Habits of the Helmeted Guineafowl (*Numida Meleagris* Linnaeus, 1758) in the Derived Savanna of Ofaji, Kogi State, Nigeria. *Direct Research Journal of Biology and Biotechnology*. Vol. 12(1), Pp. 13-22.
<https://doi.org/10.26765/DRJBB56750360>

meleagris) is considered a sector for poverty reduction in West African countries, especially in Togo, and contributes to meeting the population's animal protein requirement (Abdallah and Oluwaseun, 2025; Atitso *et al.*, 2025; Salgado, 2026). According to Karadaq (2025), within the livestock sector, poultry species including Guinea fowl are of great socio-cultural values, and significant in providing employment and contributing to national economies.

Domestication of Guinea fowl commenced over 2000 years ago, compared with other livestock, there are limited researches as it has not been given the deserving attention (Rahman *et al.*, 2025).

Though Helmeted Guinea fowl is a widespread and abundant resident game bird species in sub-Saharan Africa, and throughout the region, including Ethiopia, knowledge of the species' ecology and behavior in many parts of the country is limited (Yihenew *et al.*, 2023). The availability and type of foods an organism takes depend on the plants and animals that make up its foraging environment.

Following a study on three Galliform species; Clapperton's Francolin (*Pternistis clappertoni*), Helmeted Guinea fowl (*Numida meleagris*) and Stone Partridge (*Ptilopachus petrosus*), Yihenew *et al.* (2023) advocated community-based conservation intervention to protect Galliformes.

Rahman *et al.* (2025) advocated community-based breeding programme to enhance productivity, conserve and improve the genetic resources in guinea fowl for full utility and sustainable agricultural advancement in Africa. More so, Aynalem *et al.* (2023) suggested a dire need for research and conservation efforts to maintain guinea fowl breeding and foraging areas.

Research into the nutritional requirements of an organism is important effort towards conservation. There is great need to take specific and practical steps to conserve the Helmeted Guinea fowl especially as their natural habitats are being increasingly destroyed by anthropogenic activities.

According to the Federal Department of Forestry, Nigeria (2018) in a report on National Forest Reference Emission Level (FREL), the Derived Savanna constitutes an East-West band between the Lowland rainforest and Guinea Savanna ecological zones. The appearance and composition is almost the same as in the Southern areas of Guinea Savanna. However, due to man's interference, there is a considerable reduction of vegetation, always trying to regrow thus creating a "derived savanna". Kogi State is in the derived savanna zone.

Ofaji (in Kogi State) is undoubtedly characterized by derived savanna features as the original forest vegetation of Ofaji has been remarkably degraded due to bush burning, extended agricultural activities, tree felling, Fulani herdsman settlements and frequent grazing. In addition to these human disturbances, negative impacts of climate change (that often manifest as distorted rainfall and harmattan patterns) have probably resulted to the loss of

natural vegetation cover, leading to habitat fragmentations in the vegetation. However, the ecological fortune of the area is still being protected by the difficult undulating terrains, some hardy perennial trees, cashew plantations, grasses and streams that supply water all year round. In Kogi East of Nigeria, Ofaji is still home to some rare flora and fauna species, including the Helmeted Guinea fowl. Jacob and Pescatore (2022) asserted that, Helmeted Guinea fowl is endemic to Africa where temperature and rainfall appear to have played important roles in the ecology and evolution of the bird species. Given the adaptive ability of Helmeted Guinea fowl to varied geographical locations, high nutritional values and resistance to some avian diseases, its production has the potential to boost animal protein supply in many parts of the world. Hence, the need for conservation and improved domestication (Musundire *et al.*, 2017; Ebegebulem, 2018). Confinement of Helmeted Guinea fowl lowers their fertility rates (Sarica *et al.*, 2019; Portner 2022) reported that in domestication, Helmeted Guinea fowl are fed with kitchen wastes, corn, sorghum and millet. In a study of Guinea fowl farming in rural communities in Northern Ghana, Abdallah and Oluwaseun (2025) reported that farmers favour semi-intensive system, feeding their birds with supplemented feeds and that the birds are raised for sale and home consumption. There are several studies on *N. meleagris*, but there have not been a strict investigation of the nutritional needs of the bird in terms of sex, age and seasonal quantitative frequency, most particularly in the study area. These dietary data are thought to be of importance in formulating appropriate rations for the bird in domestication. With proper nourishments, the bird's retention at home would probably increase.

Gregory (2024) rightly asserted that knowledge of bird nutrition is constantly evolving due to heightened awareness of the importance of nutrition and increased research into birds' different needs. In nutritional ecology, it has been observed that organisms adjust their foraging strategies to cope with seasonal resource fluctuations. Optimal Foraging Theory (OFT) predicts that generalists should expand their dietary niche when high quality resources are scarce (Zheng *et al.*, 2026). Based on the optimal foraging theory, an animal's choice of food depends on availability, access safety and ease of handling, all in the bid to maximize net energy gain and survival fitness across seasons.

To enhance our knowledge base of ecological relationships towards conservation, food habits of some birds have been studied. Islam (2020) reported that black francolins are omnivorous. Similarly, the white-crowned robin-chat (*Cossypha albicapilla*) in the family Muscicapidae was reported to feed on some insects and fruits (Greater Los Angeles Zoo Association, 2024).

In a nutritional experiment, Patrik *et al.* (2025) found that Moringa oleifera leaf powder incorporated into local guinea fowl breeders' diet at 0.5%, 1% and 1.5% improve keets production. In an account on the food habits of pigeons

and doves (the columbids), Brampvet Care, 2024; Gregory *et al.*, 2024), reported that the birds feed on some species of arthropods, melon, rice peels, corn, papaya, pepper, tomatoes and some wild seeds. Adding that avocado is potentially harmful to the birds.

For optimal growth and reproduction, every organism requires adequate nutrition. What constitute the balanced diet and preferred foods of a species may differ from one location to another. Hence, the need to investigate what constitute the diet of *N. meleagris* in Ofaji cannot be over emphasized. This will hopefully improve domestication, fertility and hatching rates of the bird. Explaining the impact of domestication, Rosenberger *et al.* (2026) noted that domestication process has had substantial and varied impacts on animals in terms of anatomy, physiology and behaviour.

To improve the production and conserve Helmeted Guineafowl, adequate knowledge of the bird's choice of plant and animal diets per age, sex and season are undoubtedly vital. The prevailing unguarded killing of this bird in the study area can result in local extinction.

For reasons of conservation, adequate knowledge of the food habits, and seasonal food requirements of *N. meleagris* at the site are considered very necessary in enhancing productive domestication. Hence this study.

METHODOLOGY

Study Area

The study was carried out in Ofaji vegetation, Abocho, Kogi State, Nigeria. Ofaji is located between latitudes 7.61° 87'45" and 7.59° 33'54" North of the equator, and longitudes 6.98° 50'91" to 7.02° 66'50" East of the Greenwich meridian. The location was chosen because the birds were seen killed in large numbers by hunters and being sold within the communities and along the roads.

Collection of the birds

Collection of the birds commenced on January 5, 2022. The period of collection was divided into two; off-farming period; January to April (dry season), and farming period; May to December (wet season) respectively. The design was to observe probable change in rate of consumption of the respective food items during the farming and off-farming periods. To ensure random sampling of the bird, the vegetation was divided into four portions (Quarters), namely; Northern right quarter (Q1), Northern left quarter (Q2), then, Southern right quarter (Q3) and Southern left quarter (Q4) with the Okate-Ofaji-Ajokenyi minor road as the imaginary central line. The Northern right quarter (Q1) shares boundaries with the fallowed land portions behind Ajedimokwu, Ajibedo, Omadene and Ajakagwu villages. While the Northern left quarter (Q2) terminates along the Olowa-Dekina road. The Southern right quarter of the

vegetation (Q3) shares boundaries with Okate, Ojogba and Ofaji-Odeto villages. While the Southern left quarter (Q4) bounded with the adjoining farmlands besides Abocho, Ofoda and Odomebie communities. Local guns were used for instant killing which ensured that ingested food items do not get digested before isolation. For the farming period sampling, 8 birds were collected from each of the quarters (Q1, Q2, Q3 & Q4), while one freshly killed bird was bought from hunters along the Okate-Ofaji-Ajokenyi central road, making a total of 33 birds. During the off-farming period, 8 birds were also collected from each of the quarters, and two killed birds were bought from hunters along the central road, making a total of 34 birds for the period. Thus, the total bird (Helmeted Guineafowl) sample across the two periods of collection was sixty-seven (67).

Ethical considerations

The choice to kill the birds was guided by the Department of Biological Sciences of Federal University Lokoja, based on the bird's abundance in the study area, and the IUCN classification of the species as of "least concern" given the species' extremely large range and stable population (IUCN, 2022). The department gave approval for 60-70 as against the sample size of 100 birds proposed. However, care was taken in obtaining the sample size in order not to deplete the bird's population at the locality. To achieve this, three birds already killed and displayed for sale at roadside by hunters within the central area were purchased to make the sample population. On collection, the full body length of each of the birds was taken, then, dissected (using dissecting tools) to observe the testes and ovaries for sex identification, and to isolate ingested food items from the crop and gizzard. The ingested food items in the crop and gizzard (of every bird) were isolated and kept in separate petri-dishes and labeled appropriately for identification and recording.

Age and Sex Classification of the Species

The age groups (immature or matured), and sexes (male/female) of the birds were checked and noted. Birds of full-body-lengths of 49 cm and below were said to be immature, while those of full-body-lengths of 50 cm and above, and whose sex can be clearly identified by the helmet and wattle were regarded as matured birds. So, this classification was guided by observation of how vividly, the length and curves of the helmets and wattles indicate the sex of the birds.

Food Identification and Sorting

The isolated food items were carefully observed, identified and categorized. Food identification was aided by the combination of Automated taxonomic identification, Seed Image Database, Dataset of insect images, Entomological

Magazines, and International journal of Tropical insects Sciences (Valan *et al.*, 2019; Chiranjeevi *et al.*, 2025; Head *et al.*, 2025; Richa *et al.*; (2025); Yasin *et al.*, 2025; Maquart, 2026). Elderly men and women were also consulted for Igala (local language) names of both plant and animal food items. Igala is the dominant ethnic tribe in Kogi State. Unidentified seeds were planted in polyethene bags and the seedlings were properly identified and confirmed.

Data Analysis

To deduce food preference of the species, percentage frequency of occurrence of each food item was computed for off-farming and farming periods using the relation;

$$F = n/N \times 100,$$

where

F = % frequency

n = total number of a specific food item

N = total number of all the food items collected

The general food preference was based on total percentage frequency of each food item obtained by sum of food counts for both off- farming and farming periods divided by sum total for both periods multiplied by 100.

Food preferences for both plant and animal foods were determined by ranking the food items. Items with percentage frequency above 5% were considered most preferred, while those with 2.60 to 5% were said to be moderately preferred and those with 0.01 to 2.59% were the less preferred. Independent Samples T-test was used to determine differences in food items consumed by the species on the bases of age, sex and season of collection. Variation in food consumption was observed based on types and quantities of food items collected across the two periods of the year.

RESULTS

Sexing the birds showed that thirty (30) were males, while thirty-seven (37) were females. Out of the thirty (30) males, fifteen (15) were classified as matured, while the remaining fifteen (15) formed the immature males. Out of thirty-seven (37) female birds collected fifteen (15) were matured females, while twenty-two (22) were immature.

Food Items Collected from the Crops and Gizzards of *N. meleagris*

A total of forty-two (42) food items were isolated from the gut content of the birds. Out of this, Eighteen (18) were animal items (in the forms of whole organisms, nymphs and larvae) (Table 1), while twenty-four (24) were plant products (mainly fruits and seeds) (Table 2).

Seasonal Variation in the Occurrence of Animal Food Items

For animal food items, there was a total food count of 311 (53.71%) during the off – farming period, compared with 268 (46.29%) during the farming period.

Among the animal food items collected, cricket (*Gryllus bimaculatus*) was only present during the farming period, while Brown scorpion (*Pandinus imperator*) was only collected during the off-farming period. The other animal food items occurred in both the off - farming and farming periods.

Seasonal variation in the occurrence of plant food items

It was observed that seven of the food items obtained from the gut contents of the birds only occurred during the farming period. While, only two plant food materials namely; cassava and smooth crabgrass were only collected during the off-farming period. Fifteen (15) out of the food items collected occurred during both periods of the collection (Table 2).

Preference for Animal Food During the off - Farming Period

Among the animal food materials collected during the off-farming period, the most preferred food items were army ants (17.68%), termites (14.75%), banded sugar ants (11.25%), black garden ants (9.00%), cockroaches (8.04%) and fire ants (7.72%). Food items classified as moderately preferred were earwigs (4.82%), butterflies (4.20%), centipedes (3.85%), ticks (3.22%), praying mantis (2.90%), scorpion (2.89%) and houseflies (2.60%). The less preferred animal food items were earthworms (2.25%), desert locust (1.93%), spider (1.61%) and grasshopper (1.28 %) (Table 1).

Preference for Animal Food during Farming Period

The percentage frequencies of animal food materials during the farming period showed that army ants (14.93%), black garden ants (13.06%), termites (11.19%), banded sugar ants (9.33%), cricket (9.33%), earwig (7.46%), earthworm (5.59%) and cockroaches (5.23%) were the most preferred. Moderately preferred animal food items were centipede (4.48%), spider (3.73%), housefly (3.35%), grasshopper (2.99%) and praying mantis (2.61%). Conversely, fire ants (2.24%), butterfly (1.87%), locust (1.86%) and tick (0.75%) were the less preferred food items (Table 1).

Preference for Animal Food Materials across both the Farming and Off-farming Periods

The most preferred food items across off-farming and

Table 1: Percentage occurrence of animal materials that constituted the diet of *N. meleagris* in off-farming10 (January-April) and farming period (May-December) of 2022.

S/N	Common Name	Off-farming Period		Farming Period		Total % Frequency
		Food count	% Frequency	Food count	% Frequency	
1	Army ants	55	17.68*	40	14.95*	16.40*
2	Termites	46	14.79*	30	11.19*	13.13*
3	Black garden ants	28	9.00*	35	13.06*	10.9*
4	Banded sugar ants	35	11.25*	25	9.33*	10.36*
5	Cockroaches	25	8.03*	14	5.22*	6.74*
6	Earwig	15	4.82	20	7.46*	6.04*
7	Fire ants	24	7.72*	06	2.24	5.18*
8	Cricket	---	---	25	9.33*	4.32
9	Centipede	12	3.86	12	4.48	4.15
10	Earthworm	07	2.25	15	5.59*	3.79
11	Butterfly	13	4.2	05	1.87	3.11
12	Housefly	08	2.57	09	3.36	2.94
13	Praying mantis	09	2.89	07	2.61	2.76
14	Jumping spider	05	1.61	10	3.7	2.59
15	Grasshopper	04	1.29	08	2.99	2.07
16	Tick	10	3.22	02	0.75	2.07
17	Desert locust	06	1.93	05	1.87	1.90
18	Brown scorpion	09	2.89	---	---	1.55
	TOTAL	311	100	268	100	100

Key: Most preferred* (Above 5% and asterisk), moderately preferred (2.60 – 5%) less preferred (0.01 - 2.59%11

Table 2: Percentage occurrence of plant materials that constituted the diet of *N. meleagris* in off-farming (January-April,) and farming periods (May-December) of 2022.

S/N	Common Name	Off – Farming Period		Farming Period		Total %	Frequency
		Food count	% Frequency	Food count	% Frequency		
1	Guinea grass	253	11.71*	342	10.15*	10.76*	
2	Cowpea (beans)	---	---	460	13.65*	8.32*	
3	Bushveld Peacock berry	340	15.73*	91	2.70	7.79*	
4	African balsam plant	259	11.90*	150	4.50	7.39*	
5	Guinea corn	65	3.00	313	9.29*	6.84*	
6	Bridelia	315	14.57*	63	1.87	6.84*	
7	Itch grass	165	7.63*	182	5.40*	6.28*	
8	Maize	90	4.20	242	7.18*	6.00*	
9	Pigeon pea	210	9.72*	122	3.62	6.00*	
10	Sesame	45	2.10	275	8.16*	5.79*	
11	African oil palm	160	7.41*	154	4.57	5.68*	
12	Elephant grass	20	0.93	216	6.40*	4.28	
13	Melon	---	---	185	5.50*	3.35	
14	Millet	44	2.00	95	2.82	2.51	
15	Giant star grass	---	---	95	2.82	1.70	
16	Groundnut	61	2.82	30	0.89	1.65	
17	Rice	---	---	90	2.67	1.63	
18	Soya beans	24	1.11	62	1.84	1.56	
19	Tomato	---	---	65	1.93	1.18	
20	Cassava	65	3.00	---	---	1.18	
21	Pepper	---	---	64	1.90	1.16	
22	Pawpaw	20	0.97	37	1.10	1.03	
23	Egg plant	---	---	35	1.04	0.63	
24	Crabgrass	25	1.2	---	---	0.45	
	TOTAL	2 161	100	3 368	00	100	

Key: Most preferred* (above 5% and asterisk), moderately preferred (2.6 to 5%), less preferred (0.01 to 2.59%)

farming periods were, army ants (16.40%) followed by termites (13.13%), black garden ants (10.88%), banded sugar ants (10.36%), cockroaches (6.74%), earwig (6.04%) and fire ants (5.18%). Cricket (4.32%), centipede (4.15%), earthworms (3.79%), butterfly (3.11%), and housefly (2.94%), praying mantis (2.76%) and spider (2.60%) were moderately preferred. While, grasshopper (2.07%), tick (2.07 %), desert locust (1.89%) and brown scorpion (1.55%) were the less preferred food items (Table

1).

Preference for plant food during the off - farming period

Based on the ranked percentage frequencies of isolated plant food items during the off- farming period; Bushveld peacock-berry (15.73%), Bridelia (14.57%), African balsam plant (11.90%), Guinea grass (11.71%), Gigeon

pea (9.72%), Itch grass (7.63%) and African oil palm (7.41%) were the most preferred plant food materials. Moderately preferred items ranged from maize (4.20%), guinea corn and cassava (3.00% each) to groundnut (2.82%). Sesame (2.10%), millet (2.00%), smooth crabgrass (1.20%), Soy beans (1.11%), pawpaw (0.97%) and Elephant grass (0.93%) were the less preferred plant food materials during the period (Table 2).

Preferred plant food during the farming period

During the farming period, Cowpea (beans) (13.65%), Guinea grass (10.15%), Guinea corn (9.29%), Sesame seeds (8.16%), Maize (7.18%), Elephant grass (6.40%), and Melon (5.50%) and Itch grass (5.40%) were the most preferred plant food materials. Food items in the moderately preferred category were African oil palm (4.57%), African balsam plant (4.50%), Pigeon pea (3.62%), Millet and Giant star grass (2.82% each), Bushveld peacock-berry (2.70%) and Rice (2.67%). The least preferred plant materials were Tomato (1.93%), Pepper (1.90%), Bridelia (1.87%), Soy beans (1.84%), Pawpaw (1.01%), Eggplant (1.04%), and Groundnut (0.89%) (Table 2).

Preferred plant food materials in both dry and wet seasons of collection

Generally, it was found that the most preferred plant food material by *N. meleagris* in Ofaji vegetation were Guinea grass (10.76%), Cowpea (8.32%), Bushveld peacock-berry (7.79%), African balsam plant (7.39%), Guinea corn and Bridelia (6.84% each), Itch grass (6.28%), Maize (6.00%), Pigeon pea (6.00%), Sesame (5.79%) and African oil palm (5.68%). Moderately preferred plant food items were elephant grass (4.28%), melon (3.35%) and millet (2.51%) respectively. However, Giant star grass (1.70%), Groundnut (1.65%), Rice (1.63%), Soy beans (1.56%), Tomato and Cassava (1.18% each), Pepper (1.16%), Pawpaw (1.03%), Eggplant (0.63%), and Smooth crabgrass (0.45%) were the less preferred (Table 2).

Statistical Comparison

Plant and animal food items across seasons

Comparing intake of plant and animal food items across farming and off-farming periods, T- test analyses showed that there was no significant difference ($t = -1.536$, $P = 0.131$) in the mean values of plant items consumed during the farming and off-farming periods. Similarly, there was no significant difference ($t = 0.354$, $P = 0.726$) between the mean values of animal food items consumed by the bird during the farming and off-farming periods.

Consumption of Food Items on the Basis of Age

On the basis of age, consumption of animal food items was

significantly higher in immature birds than in matured birds ($t = 2.293$, $p = 0.028$). Immature birds had a higher mean consumption value of 20.22 as against 10.94 for matured birds. However, there was no significant difference ($t = 0.143$, $p = 0.887$) in the consumption rate of plant food materials between the matured and immature birds.

Consumption of Food Items on the Basis of Sex

Comparison of food intake based on sex of the birds showed no significant difference in the bird's consumption of plants ($t = -0.099$, $p = 0.922$), and animals items ($t = -0.092$, $p = 0.824$). Another observed habit is that of whole swallow. In most cases, the birds swallowed their foods whole. Undigested food materials in the crop were often whole grains or seeds with arthropods in their complete and intact forms. Common, scientific and Igala native names along with parts of animal and plant items consumed are shown on (Tables 3 and 4) respectively.

DISCUSSION

Variations in the occurrence of animal food items across the periods of collection

Cricket (*G. bimaculatus*) was only available during the farming period as cricket eggs hatch following the onset of rainy season. Female crickets lay eggs when the weather cools and the eggs hatch between March and May (early spring), such that, their young ones and adults would only be common during the planting/harvest period. Having worked on product quality of Field Cricket (*Gryllus bimaculatus*) and Black Soldier Flies (*Hermetia illucens*), Korir (2025) reported that optimal temperature and relative humidity favours sustainable insect production. Brown scorpions were only collected during the off-farming period possibly due to availability. They dwell in the leaf litters and more often, come out of hiding places during hot weather of the extreme dry season. Scorpions breed during the warm months and feed actively searching for water. Scorpions play important ecological roles in agricultural landscapes (de Azevedo Gonzaga, 2025). The higher percentage in consumption of insect during the off-farming period (Table 1) could be due to the absence of complementary arable crops on the field at the time. The birds therefore forage more intensely to pick arthropods from their hiding places.

Food preferences in both the farming and off-farming periods

The most preferred food organisms (arthropods) are known to reproduce large numbers of offspring and also show the social habit of staying and moving together in groups. So, are often available in good numbers at a location. Consequently, were easily accessible by the Helmeted Guineafowl.

Table 3. Animal Materials that Constituted the Diets of *Numida meleagris*

S/N	Common Name	Scientific Name	Igala Name	Part or Form Consumed
1	Army ants	<i>Anommia nigricans</i>	Onufa	Whole Organism
2	Termites	<i>Macrotermes bellicosus</i>	Unyi/ Ekwu	Whole Organism
3	Black garden ants	<i>Lasius niger</i>	Akpiti egini	Whole Organism
4	Banded sugar ants	<i>Camponotus consobrinus</i>	Ikpolo	Eggs and whole Organism
5	Cockroaches	<i>Periplaneta Americana</i>	Ayipele	Eggs and whole Organism
6	Earwig	<i>Forficula acricularia</i>	Akpeno	Whole Organism
7	Fire ants	<i>Solenopsis invica</i>	Emenye	Whole Organism
8	Cricket	<i>Gryllus bimaculatus</i>	Ole/ Olule	Whole Organism
9	Centipede	<i>Scolopendra gigantea</i>	Umekpo	Whole Organism
10	Earthworm	<i>Lumbricus terrestris</i>	Idenekwu	Whole Organism
11	Striped tiger Butterfly	<i>Danaus plexippus</i>	Achibebene	Whole Organism
12	Housefly	<i>Musca domestica</i>	Achichi	Whole Organism
13	Praying mantis	<i>Mantis religiosa</i>	Ogogo	Whole Organism
14	Jumping spider	<i>Acarina domestica</i>	Agara	Whole Organism
15	Grasshopper	<i>Zonocerus variegatus</i>	Akpachi	Whole Organism
16	Tick	<i>Argas persicus</i>	Iko	Whole Organism
17	Dessert locust	<i>Schistocerca gregaria</i>	Akpachi egbili	Whole Organism
18	Brown scorpion	<i>Pandinus imperator</i>	Akpe egini	Whole Organism

Table 4. Plant Materials that Constituted the Diets of *Numida meleagris*.

S/N	Common Name	Scientific Name	Igala Name	Part or Form Consumed
1	Guinea grass	<i>Panicum maximum</i>	Iyo	Tarsel/seed
2	Cowpea (beans)	<i>Vigna unguiculata</i>	Egwa	Whole seed/ split cotyledon and succulent pods
3	Bushveld Peacock berry	<i>Margaritaria discoidea</i>	Ode	Seed/ fruit
4	African balsam plant	<i>Daniellia oliveri</i>	Oli Agba	Tender buds
5	Guinea corn	<i>Sorghum bicolor</i>	Okoli	Grain (and cover)
6	Bridelia	<i>Bridelia ferruginea</i>	Ede	Seed/ fruit
7	Itch grass	<i>Rottboellia cochinchinensis</i>	Agahama	Seed
8	Maize	<i>Zea mays</i>	Akpa	Grain
9	Pigeon pea	<i>Cajanus cajan</i>	Agwugwu	Seed
10	Sesame	<i>Sesamum indicum</i>	Igogo	Seed
11	African Oil palm	<i>Elaeis guineensis</i>	Ekpe	Whole (small) fruits and Epicarp/Mesocarp peels
12	Elephant grass	<i>Pennisetum purpureum</i>	Egbe Ikpo	Seed bract
13	Melon	<i>Cucumis melo</i>	Apii	Seed
14	Millet	<i>Pennisetum typhoideum</i>	Okodu/ Ahahi	Grain
15	Giant star grass	<i>Cynodon lectostachyum</i>	Omaye chisha	Fine tassel/ seed
16	Groundnut	<i>Arachis hypogea</i>	Opa	Seed
17	Rice (with husk)	<i>Oryza sativa</i>	Ochikapa	Grain (with husk)
18	Soya beans	<i>Glycine max</i>	Egwa soya	Seed
19	Tomato	<i>Lycopersicum esculentum</i>	Tomato	Ripe(soft) fruit and Seed
20	Cassava	<i>Manihot esculenta</i>	Abacha	Decaying (exposed) tuber
21	Pepper	<i>Capsicum annum</i>	Akpo/Akpoko	Seed
22	Pawpaw	<i>Carica papaya</i>	Echibakpa	Ripe (soft) fruit and Seed
23	Eggplant	<i>Solanum melogena</i>	Ika	Succulent fruit/seed
24	Smooth crabgrass	<i>Digitaria ischaemum</i>	Aicha	Tassel/seed

The moderately preferred food organisms do not reproduce their offspring in large numbers and are rarely found staying or moving together. Most of them also hide to avoid their predators. For instance, earwigs, scorpions, spiders and centipedes take cover in leaf litters, shallow holes and loose bark of trees. Apart from hiding in dark garbage, cockroaches and scorpions are often nocturnal. Butterflies perch on flowers of tall grasses and shrubs to escape from their terrestrial predators like the Helmeted Guineafowl.

The low intake of ticks (an ectoparasite) might be due to little population of their host organisms in the vegetation. Praying mantis, grasshoppers and locust fly or hop actively

and also blend well in camouflage with brown-green colour of the vegetation. These probably reduced their visibility to Helmeted Guineafowl. More so, the low count for houseflies was probably due to non-availability of their attractants such as low-height odorous flowers and decaying organic matter. Fire ants being most preferred in the off-farming period but least preferred in the farming period could be due to availability based on breeding season. Fire ants reproduce in the late dry season mostly on fruiting perennial trees and some grasses. Similarly, earthworms were among the least preferred food organisms in the off-farming period as they hide below the hard soil surface, but were on the list of most preferred

food organisms in the rainy/farming period which is their breeding season, and the birds could easily dig up the wet and soft soil surface to extract the worms. Cricket was only available in the farming period (early rainy season) when the eggs usually hatch. Mitchaothai *et al.* (2024) reported that an incubation temperature of 30°C and Relative Humidity of 78% resulted in a hatching rate of 79.75% for *Gryllus bimaculatus*. During the off-farming period, the birds consumed a lot of arthropods and seeds of some wild fruiting plants. These may be attributed to the fact that at this period of late dry season when remnants of cultivated crops are scarce on the farm, the birds engage in intensive foraging; feeding on hidden arthropods that had taken cover due to harsh environmental conditions. In the absence of cultivated legumes, arthropods serve as major sources of protein for the birds. However, during the planting and harvest period (May-December), they fed on several seeds of cultivated crops and weeds. The Helmeted Guineafowl has been recognized as an excellent insectivore for effective biological control of insect pests. Del Moral de la Vega *et al.* (2026) reported the choice for Helmeted Guineafowl in the control of a locust species; *Dociopterus maroccanus* in Spain following the locust plague in Extramadura in 2011.

Variations in the occurrence of plant food items across the periods of collection

Some plant food items were only collected during the farming period, but absent during the off-farming period, possibly because their seeds in the last harvest season could not persist in the field in viable or recognizable forms during the off-farming period. Cassava and crabgrass were only collected during the off-farming period. These could be due to the facts that, during the farming period, cassava was being newly planted and only growing at tender age. The matured roots which Helmeted Guineafowl eats were mostly available during the latter off-farming period.

However, other plant food materials being available during both periods of the collection were probably due to their frequently repeated or perennial life cycles, longer periods of seed dormancy and viability of planting materials in the vegetation. Accordingly, Amanda and Alyssa (2023) noted that perennial plants live for many years and need little care to bloom all year round. Seasonal variations in percentage occurrence of animal food could also be due to life cycles of the preys and weather factors.

On the basis of age, consumption of animal food items being significantly higher in immature birds could be due to the fact that younger birds require adequate protein diets (mainly in the forms of insect larvae, nymphs and smaller arthropods) for fast growth and good health. Ariane (2021) noted that insects mainly contain protein, minerals, fibre and vitamins. Meghan (2023) reported that guinea keets require higher protein ration than chicken

chicks. This finding is consistent with Nicolas *et al.* (2022) who reported that younger animals eat more of protein diets which are important for fast growth and development of vital tissues and organs. Related to these observations, Birdfact (2023) noted that, baby Helmeted Guineafowl (keets) eat various foods, but their diet is more or less focused on soft insects. Thus, insects are valuable feed supplements. Buttressing the importance of protein diet, Korankye *et al.* (2026) found that feeding Guineafowls with low protein diet affects growth performance negatively.

Generally, during rainy season, when young insects are more available, the birds eat a lot of Grasshoppers, Crickets, Ants, Beetles, Spiders, pupae and many other arthropods and invertebrates. Orounlati *et al.* (2025) reported that the birds (Helmeted Guineafowl) are known for high quality meat and egg, and usually have access to abundant food during rainy season.

But during the cold dry season, Helmeted Guineafowl search intensely to find seeds, insects and other small animals. It is also important to note that in the absence or low availability of cultivated crops, some wild plant species serve as dependable complements. However, Ovat *et al.* (2022) found that, there was significant difference in availability of food materials for *N. meleagris* during wet season ($F = 51.7$, $P = .00$) and dry season ($F = 53.3$, $P = .00$).

The habit of whole swallow has also been observed among other birds, this perhaps ensures that foods eaten undergo slow digestion, and by implication, would sustain the bird for a longer period of time. Daniet *et al.* (2025) reported that Barn Owls (*Tyto furcata*) swallow their preys whole. Fan *et al.* (2026) in a study of the diet of bird-like troodontid dinosaurs, also reported the behavioural feeding strategy of ingesting whole prey. Other birds that ingest their preys whole and alive include Osprey, Kingfisher, Pelican, and Heron. Whole swallow seems to be a foraging fitness.

Observations showed that the Helmeted Guineafowl (*N. meleagris*) in Ofaji vegetation were farmer friendly as they hardly dig up or destroy cultivated seedlings. Also, they do not fly or climb up trees or crops to eat. They feed on fallen fruits and seeds, or when lowered near ground level within their reach. Ebegebulem (2018) attested that Helmeted Guineafowl was an ideal bird in integrated crop-livestock farming system. In agreement with this observation, Jacob (2023) stated that as an agent of biological control, the Helmeted Guineafowl in the wild mainly feed on arthropods such as grasshoppers, and flies on the farm without affecting the crops. Adeniyi and Ahmad (2024) stated that the pest control services of *N. meleagris* contribute to healthier crop production, lower input cost and environmentally sustainable farming practice. Studies have shown that *Francolinus clappertoni* (in the order Galliformes) is euryphagic. *N. meleagris* also being a member of the order Galliformes may suggest that this food habit could be genealogical. In line with these, in captivity, it is vital to provide Helmeted Guineafowl with

balanced diets that include insects, fruits, seeds and leaves.

Conclusion

Generally, Helmeted Guineafowl is euryphagic in food habit. This is due to the bird's adaptive ability to utilize wide varieties of food materials of both plant and animal sources across varied seasons. Considering percentage occurrences of plant and animal food materials (all together), the first three most preferred food items were insects; Army Ant, Termites, and Black garden Ants. It is advisable that these insects be provided for Helmeted Guineafowl in domestication as sources of protein, mineral and unsaturated fats. Also, considering percentage occurrence of plant food materials, out of the top seven most preferred, only two; (cowpea and guinea corn) were cultivated crops. Therefore, one may deduce that *N. meleagris* generally prefers more of animal foods (arthropods) and wild plant resources to cultivate and home based food materials, and these could account for the bird's incessant disappearance into the wild. Finally, the bird's preference for food seems to depend on availability and accessibility.

Recommendation

Helmeted Guineafowl farmers should feed their birds with the identified natural food items, provide cover for *N. meleagris* and breeding environment for invertebrates that serve as food organisms for the bird.

Acknowledgements

We are grateful to the staff of Biological Sciences Department, Federal University Lokoja who helped in the scientific identification of some of the food organisms. We are also quite thankful to Rajitha Induni Weithara (an online friend from Sri Lanka) who helped in the scientific identification of "Ode" plant; Bushveld Peacock-berry as (*Margaritaria dicoidea*) in the family Phyllanthaceae.

REFERENCES

- Abdallah, N., Oluwaseun, O.A. (2025). Socio-economic and production dynamics of Guinea fowl farming in Northern Ghana: insights into health management, challenges, and climate change impacts. *Trop Anim Health Prod* 57, 181. <https://doi.org/10.1007/s11250-025-04427-2>. Available at <https://link.springer.com/article/> [accessed 24 February 2026].
- Adeniyi, R.T., Ahmad, K.S. (2024). Significance of information resources to integrated pest management usage among poultry farmers. Kwara State, Nigeria: agricultural technology transfer. *Kajian Masalah Socila Ekonomi Pertanian dan Agribisnis, Jurnal AGRISEP*, pp 405-424, Doi:10.31186/jagrisep.23.02.424. Available at <https://www.researchgate.net/publication/384055157-significance-> [accessed 24 February 2026].
- Amanda, G., Alyssa, G. (2023). *Perennial Flowers that bloom all year*. Available at <https://www.goodhousekeeping.com/home/gardening> [accessed 6 April 2023].
- Ariane, L. (2021). Nutritional value of Ants. Available at healthline.com/nutrition/eating-ants#nutrients [accessed 15 October 2022].
- Atitso, P. N. K., Voemesse, K., Akue, A., Meteyake, H.T., and Tete-Benissan, K. A. (2025). Effect of dietary incorporation of Moringa oleifa leaf meal on hatching characteristics and serum parameters of local Guinea fowl (*Numida meleagris*) in Togo. *Journal of Advanced Veterinary and Animal Research*, Vol. 12, No. 4, PP. 1201 -1210. <http://doi: 10.5455/javar.2025.1980>
- Aynalem, Y., Bekele, A. & Bogale, B.A. (2023). Breeding biology of the helmeted guineafowl (*Numida meleagris*, Linnaeus 1758) in Western Ethiopia, *Ornithol. Springer. Res.* 31, 173-181. <https://doi.org/10.1007/s43388-023-00132-6> [accessed 23 February 2026].
- Birdfact. (2023). What do Guineafowl Eat? Available at <https://birdfact.com/article/what-do-guineafowl-eat>. [accessed 6 April 2023].
- Brampveter Care. (2024). Feeding Pigeons and doves-Brampveter Care. Available at <https://bramptonvereinarian.com/feeding-pigeon-and-doves>. [accessed 11 December 2025].
- Chiranjeevi, S., Saadati, M., Deng, Z. K., Koushik, J., J., Jubery, T. Z., Mueller, D. S.,... and Ganapathysubramanian, B. (2025). InsectNet: Real-time identification of insects using an end-to-end machine learning pipeline. *PNAS nexus*, 4(1), pgae 575 [accessed 15 February 2026].
- de Azevedo Gonzaga, L. E., De Lima, J. R., Da Silva, M. A., De Moura, G. J. B. & de Araujo Lira, A. F. (2025). Traditional ecological knowledge of scorpion in human communities in a Brazilian semiarid region. *International Journal of Tropical Insect Science*, 1-11. <https://doi.org/10.1007/s42690-025-01673-7> [accessed 28 February 2026].
- del Moral de la Vega, J., Guisado, A.M., Medina, J.J., Fernandez, M.S., del Moral Martinez, J. (2026). Predatory Characteristics of the Guinea Fowl (*Numida meleagris*) Against Pest-Forming Insects: Use of *N. meleagris* Against the Locust *Dociostaurus maroccanus*. In: del MoraL de la Vega, J., del Moral Martinez, J. (eds) *The Guinea Fowl (Numida meleagris)*. Springer, Cham https://doi.org/10.1007/978-3-032-11654-3_3 [accessed 22 February 2026].
- Ebegbulem, V.N. (2018). Prospects and challenges to guineafowl (*Numida meleagris*) Production in Nigeria. *International Journal of Avian and Wildlife Biology*. 3(3):182-184. DOI:10.15406/ijawb.2018.03.00083.
- Fan, Y. C., Miller, C. V. and Pitman, M. (2026). Diet of bird-like troodontid dinosaurs synthesis of a contentious clade. *Biological Reviews*. <https://doi.org/10.1002/brv.7015>. Available at <https://onlinelibrary.wiley.co/doi/full/10.1002/brv.714500> [accessed 23 February 2026].
- Federal Department of Forestry. (2018). *National forest emission level for the Federal Republic of Nigeria, Federal ministry of environment, Nigeria and the United nations framework convention on climate change*. Available at <https://redd.unfccc.int>. [accessed 8 January 2022].
- Greater Los Angeles Association. (2024). White-crowned robin-chat. Available at <https://azoo.us8.list-manage.com> [accessed 10 January 2024].
- Gregory, R. DVM; Laurie, H. DVM; Rick Axe Ison, DVM. (2024). World-class Pet Care Resource. Available at <https://vca hospitals.com/know-your.pet/pigeons-and-doves-feeding>. [accessed 10 October 2025].
- Head, K. V. K. & Balrampur, A. N. D. (2025). Agri Magazine. *E-magazine*, 2(1).
- Islam, K. (2020). Black Francolin (*Francolinus francolinus*). Available at <https://doi.org/10.2173/bow.blkfra.01> [accessed 10 May 2023].
- IUCN Red List of Threatened Species. (2022). Available at https://www.iucnredlist.org/search?_Numida%meleagris. [accessed 05 January 2022].
- Jacob, J. (2023). Raising Guinea Fowl in small and backyard flocks. Available at <https://poultry.extension.org/article/poultry-management> [accessed 5 June 2023].
- Jacob, J., & Pescatore, A. (2022). Guineafowl. *Gamebird medicine and management*, 297-318. Doi.org/10.1002/9781119712244.ch17.

- [accessed 23 February, 2026].
- Karadaq, S. (2025). Alternative species in poultry farming and their economic, social and cultural importance. *Journal of Istanbul veterinary sciences* 9(1), 30-37. <https://doi.org/10.30704/http-www-Jivs-net.1620490>. Available at <https://izlik.org/JA74WU92TD>. Accessed
- Korankye, O., Kyere, C. G., Kagya-Agyemang, J. K., & Asabere-Ameya, A. (2026). Production Performance, Hormonal Levels, Organ and Biochemical Indexes of Guinea Fowls Fed Varied Level of Dietary Crude Protein. *Egyptian Journal of Veterinary Sciences*, 1-6. 10.21608EJVS.2025.396658.2917. Available at <https://ejvs.journals.ekb.eg/article/476893.html> [accessed 25 February 2026].
- Korir, L. C. (2025). *Product Quality of Field Cricket (Gryllus bimaculatus) and Black Soldier Flies (Hermetia illucens)* (Doctoral dissertation, COANRE-JKUAT). URL: <https://ir.jkuat.ac.ke/handle/123456789/6732> [accessed 26 February 2026].
- Maquart, P. O., Le Gall, P. (Ed). (2026). Strengthening entomological capacity in Africa through international cooperation and field training. *International Journal of Tropical Insect Science*, 1-2. Springer. Available at <https://doi.org/10.1007/s42690-026-01778-7> [accessed 25 February 2026].
- Meghan, H. (2023). How to Raise Guinea keets from Arrival to Outside. Available at <https://meyerhatchery.zendesk.com> [accessed 10 October 2023].
- Mitchaothai, J., Lertpatarakomol, R., Trairatapiwan, T., & Lukkananukool, A. (2024). Influence of incubation temperature and relative humidity on the egg hatchability pattern of two-spotted (*Gryllus bimaculatus*) and house (*Acheta domestica*) Crickets. *Animals*, 14(15), 2176. <https://doi.org/10.3390/ani14152176>. [accessed 26 February 2026].
- Moreno, V. J. P. (2026). Biological characteristics. In: del Moral de la Vega, J., del Moral Martinez, J. (eds) The Guinea Fowl (*Numida meleagris*). Springer, Cham. https://doi.org/10.1007/978-3-032-11654-3_2 [accessed 24 February 2026].
- Musundire, M.T., Halimani, T.E., Chimonyo, M. (2017). Physical and chemical properties of meat from scavenging chickens and helmeted guinea fowls in response to age and sex. PMID: 28394176, DOI: 10.1080/00071668.2017.1313961. [accessed 9 August 2022].
- Nicolas, A., Van – Leeuwen, J., Alfred, B. (2022). Young animal require higher protein concentration in their diets. In: *FeedNavigator*. Available at <https://www.feednavigator.com/News/...> [accessed 5 June 2023].
- Orounladji, B. M., Soara, A. E., Tokofai, B. M., Chrysostome, C. A., Tozo, S. K., Dayo, G. K., & Dossa, L. H. (2025). Advances in the genetic characterization of guinea fowl in Africa: a comprehensive overview of the current status, progress of genome genotyping, and future perspectives. *Poultry Science*, 104(9), 105363., DOI: 10.1016/j.psj.2025.105363. Available at <https://www.researchgate.net/publication/392165211>
- Ovat, O.I., Edet, D.I. and Iwara I.O. (2022). Effect of food availability and feeding pattern on the population spread of Helmeted-Guineafowl (*Numida meleagris*) Ovonum, Cross River State. *Journal of Contemporary Research (JOCRES)*. Research Article Vol.1 (1) ISSN: 2814-2241. Obtained from <https://unicross.edu.ng/research/file/> [accessed 5 June 2023].
- Patrik, N. K. A., Kokou, V., Aduayi, A., Hezouwe, T. M. and Kafui, A. T. (2025). Effect of dietary incorporation of Moringa oleifa leaf meal on hatching characteristics and serum parameters of local Guinea fowl (*Numida meleagris*) in Togo. *Journal of Advanced Veterinary and Animal Research*, 12(4): 1201-1210. Doi: 10.5455/javar.2025.1980. Available at <https://www.bibliomed.org/?mno=241658J>, [accessed 22 February 2026].
- Portner, M. (2022). *Numida meleagris* (online), Animal diversity web. Available at https://animaldiversity.org/accounts/Numida_meleagris. [accessed 10 January 2023].
- Rahman, S.F., Baccouri, W. & Wanjala, G. (2025). A systemic review of guinea fowl diversity and economic, socio-cultural and ecological significance in Africa. *Trop Anim Health Prod* 57,463. <https://doi.org/10.1007/s11250-025-04723-x>
- Richa, G., Gautam C. P.N., Pradeep, K., Ankit, T. and Ayush, K. (2025). Integrated Approaches for Managing Pulse Beetle Infestations. *Agri magazine*, ISSN: 3048-8656. Available at <http://www.agrimagazine.in>
- Rosenberger, J., Pawalec, L., Grugel, R. (2026). The impact of domestication process on eggshells microstructure in *Gallus gallus*, Anser anser and Anas platyrhynchos. *Czech Journal of Animal Science*, 71, 2026 (1): 30-40. <https://doi.org/10.172211/112/2024-CJAS>. Available at <https://scholar.google.com/citations?user..>
- Salgado, P. E. R. (2026). Health of the Guinea Fowl. In the Guinea Fowl (*Numida meleagris*) Integrated Management for Meat Production and pest Control (pp. 91-140). Cham: Springer Nature Switzerland. Accessed at link.springer.com/chapter/10.1007/978-3-032-11654-3_6. [accessed 22 February 2026].
- Sarica, M., Boz, M.A., Yamak, U.S., Ucar, A. (2019). Effect of production system (barn and free range) and slaughter age on some production traits of guinea fowl: Meat quality and digestive traits. *South African Journal of Animal Science*.Vol.49, n.1, pp. 192-199. ISSN 2221-4062 Available at <https://doi.org/10.4314/sajas.v49i1.22>. [accessed 23 February 2026].
- Valan, M., Makonyi, K., Maki, A., Vondracek, D., & Ronquist, F. (2019). "Automated taxonomic identification of insects with high-level accuracy using effective feature transfer from convolutional networks. *Systemic Biology*, 68(6), 876-895. [accessed 26 February 2026].
- Yasin, E. T., Ropelewska, E., Kursun, R., Cinar, I., Taspinar, Y. S., Yasar, A., & Koklu, M. (2025). Optimized feature selection using gray wolf and particle swarm algorithms for corn seed image classification. *Journal of Food Composition and Analysis*, 145,107738. [accessed 23 February 2026].
- Yihew, A., Afework, B. and Bezawork, A.B. (2023). Population size, habitat use and foraging habits of wild guineafowl (*Numida meleagris*) in southwestern Ethiopia. *Journal of African Ornithology* 94(3), pages 228.233. <https://doi.org/10.2989/00306522.2023.2266773> [accessed 22 February 2026].
- Yihew, A., Afework, B. and Bezawork, A.B. (2023). Population Status and Threats to Galliform Bird in the Arjo-Didessa River Valley, southwestern Ethiopia. *International Journal of Zoology*. <https://doi.org/10.1155/2023/5730010>. Available at <https://onlinelibrary.wiley.com/doi/10.1155/2023/5730010> [accessed 23 February 2026].
- Zheng, S., Ru, Y., Xu, M., Ma, Y., Ma, Y., & Guo, N. (2026). The Seasonal Dietary Shift and Niche Resilience of Yaks on the Quinghai-Tibetan Plateau. *Animal*, 16(4), 613. Available at <https://doi.org/10.3390/ani16040613>. [accessed 22 February 2026].