REVISTA BIO CIENCIAS
http://revistabiociencias.uan.edu.mx
https://doi.org/10.15741/revbio.13.e1836

ISSN 2007-3380

Original article / Artículo original

Feeding behavior of the Central American tapir (*Tapirella bairdii*) in captivity and bromatological analysis of six forage species in its diet

Comportamiento alimenticio del tapir (*Tapirella bairdii*) en cautiverio y análisis bromatológico de seis especies forrajeras propias de su dieta

Sánchez-Gutiérrez, F.[1], *López-De La Cruz, M.M.*[1], *Monroy-Hernández, R.*[1], *Macías-Farrera, G.P.*[2], *Méndez-Argüello, B.*[1*], González-González, C.A.[1].

[1] *Facultad Maya de Estudios Agropecuarios de la Universidad Autónoma de Chiapas, Carretera Catazajá- Palenque km 4, C.P. 29980, Catazajá, Chiapas, México.*
[2] *Facultad de Medicina Veterinaria y Zootecnia de la Universidad Autónoma de Chiapas. Calzada. Emiliano Zapata Km. 8, Del Frigorífico, 29060 Tuxtla Gutiérrez, Chiapas, México.*

ABSTRACT

The objective of this study was to determine the feeding behavior of the Central American tapir (*Tapirella bairdii*), as well as to assess the nutritional contribution, palatability, and preference of forage plant species that comprise its diet. Six tree species used as food were identified: Maya nut tree (*Brosimum alicastrum* Sw.), papaya (*Carica papaya* L.), curly dock (*Rumex crispus* L.), gumbo-limbo (*Bursera simaruba* (L.) Sarg.), guarumo (*Cecropia obtusifolia* Bertol.), and churimo (*Inga vera*). For these plants, percentages of protein, fat, neutral detergent fiber (NDF), acid detergent fiber (ADF), and mineral content were determined. Additionally, a food preference test was conducted. Results showed that the tapir preferred to consume leaves, fruits, and stems, with vegetables consumed to a lesser extent. Among the six species, gumbo-limbo had the highest ash content (16.7 %); papaya showed the highest ether extract value; the Maya nut tree contained the highest ADF concentration, while papaya had the highest NDF concentration. Regarding dry matter (DM) percentage, guarumo showed the greatest value, whereas crude protein concentration was highest in papaya and churimo.

KEY WORDS: Wildlife, nutrition, preference, tree species.

Please cite this article as/Como citar este artículo: Sánchez-Gutiérrez, F., López-De La Cruz, M.M., Monroy-Hernández, R., Macías-Farrera, G.P., Méndez-Argüello, B., González-González, C.A. (2026). Feeding behavior of the Central American tapir (*Tapirella bairdii*) in captivity and bromatological analysis of six forage species in its diet. *Revista Bio Ciencias*, 13, e1836. https://doi.org/10.15741/revbio.13.e1836

Article Info/Información del artículo
Received/Recibido: November 12th 2024.
Accepted/Aceptado: December 17th 2025.
Available on line/Publicado: February 09th 2026.

***Corresponding Author:**

Bulmaro Méndez-Argüello. Facultad Maya de Estudios Agropecuarios. Universidad Autónoma de Chiapas. Carretera Catazajá–Palenque, Km. 4, C.P. 29980 Catazajá, Chiapas, México. Teléfono: 916 100 0736. E-mail: bulmaro.mendez@unach.mx, https://www.facultadmaya.unach.mx/.

Revista Bio ciencias
ISSN 2007-3380

R E S U M E N

El trabajo tuvo como objetivo determinar el comportamiento alimenticio del tapir centroamericano (*Tapirella bairdii*), así también determinar el aporte nutricional, la palatabilidad y la preferencia de especies de plantas forrajeras que conforman su dieta. Se identificaron seis especies arbóreas utilizadas como su alimento: ramón (*Brosimum alicastrum* Sw.), papaya (*Carica papaya* L.), lengua de vaca (*Rumex crispus* L.), palo mulato (*Bursera simaruba* L. Sarg.), guarumo (*Cecropia obtusifolia Bertol.*) y guatope (*Inga vera*), dichas plantas se les determinó el porcentaje de proteína, grasa, fibra detergente neutra (NDF), fibra detergente acida (ADF) y minerales. Además, se realizó la prueba de preferencia alimenticia. Se determinó que el tapir prefiere comer las hojas, frutos y tallos, en menor grado las verduras. De las 6 especies, el palo mulato es la que presentó mayor porcentaje de ceniza (16.7 %), el extracto etéreo fue de mayor valor en la papaya; el ramón contiene más concentración de ADF, mientras que la papaya presentó mayor concentración NDF. Respecto al porcentaje de materia seca (DM) en el guarumo fue mayor; por otra parte, la mayor concentración de proteína cruda fue en papaya y guatope.

P A L A B R A S   C L A V E : Fauna silvestre, nutrición, preferencia, especies arbóreas

Introduction

The Central American tapir (*Tapirella bairdii*) is the largest terrestrial mammal of the Neotropics, commonly known as “danta” (Botello *et al*., 2014). This species is regarded as an indicator of tropical rainforest conservation status, as its presence reflects the ecological integrity of the habitat. Tapirs play a crucial role in the dynamics of tropical forests by browsing vegetation and consuming large quantities of seeds, contributing to key ecological processes such as seed dispersal, herbivory, and understory modification (Naranjo-Riñera & Cruz-Aldán, 1998; Botello *et al*., 2014; Aranda, 2019; González, 2020; Trillanes *et al*., 2024).

Beyond their ecological importance, *Tapirella bairdii* has historically served as a traditional food resource for rural Mesoamerican communities since pre-Columbian times (Yanez-Montalvo *et al*., 2021). Its wide geographic distribution, extending from southern Mexico to northwestern Colombia (Pérez-Flores *et al*., 2021), is linked to its capacity to adapt to diverse ecosystems. In Mexico, it is mainly found in the states of Campeche, Chiapas, Oaxaca, Quintana Roo, Veracruz, and Yucatán, inhabiting tropical rainforests and montane forests (Trillanes *et al*., 2024).

Tapirella bairdii is also an excellent swimmer, which enables it to inhabit areas near freshwater bodies. Its diet is predominantly herbivorous, consisting of stems, bark, leaves, young shoots, fruits, and seeds. It exhibits nocturnal feeding habits, although its diet varies according to season and resource availability, closely tied to the phenology of tropical forests, where the supply of fruits and leaves changes seasonally (Janzen, 1983; Oliveira *et al*., 2022; Trillanes *et al.,* 2024).

In captivity, three main sources of food are provided: 1) fresh forage and dry grasses, 2) energy-protein concentrates, characterized by low fiber content (< 20 %) and high digestibility (>60%), and 3) dietary supplements, including vitamins, minerals, and additional fiber sources. For calves requiring assisted feeding, formulas with optimal protein levels and moderate fiber content are recommended (López *et al*., 2022).

According to Huerta-Rodríguez *et al*. (2024), this species inhabits regions of high biological diversity and elevated endemism, underscoring its ecological importance and the urgency of its conservation. However, the Central American tapir is currently classified as endangered, mainly due to habitat loss and degradation, as well as poaching across much of its range (García *et al*., 2016). Despite its ecological and cultural relevance, studies on the biology and captive management of *Tapirella bairdii* remain limited. Therefore, the present study aims to evaluate the feeding behavior of the Central American tapir in captivity, analyze the nutritional composition of six forage species present in its diet, and determine its dietary preferences through direct in situ observations.

Materials and Methods

Study area

The study was conducted at the Miguel Álvarez del Toro Zoo (ZOOMAT), located within the "El Zapotal" Reserve in Tuxtla Gutiérrez, Chiapas, Mexico (16°72′49.81″ N; 93°09′33.973″ W), at an elevation of 670 m. The regional climate is classified as warm sub-humid with summer rains (Aw_2(w)), with an average annual precipitation of 975.4 mm. The area has a prolonged dry season from November to May and a rainy season from June to October (García, 2004; Rodríguez-López *et al*., 2019).

Sampling and identification of forage plants

Forage plant sampling was carried out between October and December 2023. Through field surveys within the ZOOMAT facilities, plant species that form part of the diet of the Central American tapir in captivity were identified and georeferenced.

Plant data collection

With the support of zoo staff, six plant species most frequently consumed by *Tapirella bairdii* were identified: Maya nut tree (*Brosimum alicastrum* Sw.), papaya (*Carica papaya* L.), curly dock (*Rumex crispus* L.), gumbo-limbo (*Bursera simaruba* (L.) Sarg.), guarumo (*Cecropia obtusifolia* Bertol.), and churimo (*Inga vera*). Of these species, three have seasonal availability, whereas the

Maya nut tree, papaya, and churimo are available year-round. For each species, one kilogram of leaves was collected and stored in labeled black plastic bags with the corresponding common name. Samples were subsequently sent to the laboratory for nutritional evaluation.

Proximate chemical analysis

Samples were sun-dried between 12:00 and 15:00 h. Once dry, the plant material was ground to determine protein, fat, neutral detergent fiber (NDF), acid detergent fiber (ADF), and mineral content, using the Proximate Chemical Analysis (PCA) technique described by Ruíz (2010).

Chemical analysis procedures

Moisture*.*

Moisture content was determined by oven-drying samples in a forced-air oven at 100-150°C until constant weight was obtained. A desiccator with calcium chloride was used to prevent rehydration. Moisture percentage was calculated as:

$$H\% = \frac{(Ws - Ds)}{Ws} x\ 100$$

Where: *Ws* = wet sample mass; *Ds* = dry sample mass.

Ash.

Ash content was determined by incinerating dry samples in a muffle furnace at 600°C for two hours. The ash percentage was calculated as:

$$C\% = \frac{(Ca - Ce)}{M} x\ 100$$

Where: *Ca* = crucible with ash; *Ce* = empty crucible; *M* = dry sample mass.

Ether Extract

Fat content was determined by solvent extraction using a Soxhlet extractor. After ether extraction, samples were dried and weighed, and the ether extract percentage was calculated as:

$$E.E.B.S\% = \frac{(Iw - Fw)}{M} x\ 100$$

Revista Bio ciencias ISSN 2007-3380

Where: *Iw* = initial sample weight; *Fw* = final weight after extraction; *M* = sample mass.

Crude protein

Crude protein content was calculated using the Kjeldahl method by determining total nitrogen content and applying a conversion factor:

$$P\% = N\%\ x\ 6.25$$

Where: N% = total nitrogen percentage.

Preference test

To assess the feeding preferences of tapirs, the method described by Plata *et al*. (2009) was used. One kilogram of each of the five plant species was offered to five tapirs in concrete feeders (60 x 110 cm), placed 10 cm apart. Frequency of visits, preference for each plant, and total consumption were recorded. Additionally, fruits and vegetables were offered to compare dietary preferences in captivity (**Table 1**).

Table 1. Amount of vegetables, supplements, and feeding times provided in tapir feeders.

Food item	Schedules	
	Servings in grams	
	8:00 a.m.	12:00 p.m.
Guava (*Psidium guajava*)	800	800
Apple (*Malus domestica*)	600	600
Papaya (*Carica papaya* L)	600.	600
Banana (*Musa paradisiaca* L)	400	400
Carrot (*Daucus carota*)	600	600
Pet roll (commercial supplement)	500	
Mazuri (protein supplement)	500	
Oats (*Avena sativa*)	250	
Mixed forage species		12,000

Revista Bio ciencias
ISSN 2007-3380

Preference and consumption test of forage species by *Tapirella bairdii*

Selection of tapirs

Four female *Tapirella bairdii* with similar physical characteristics were selected: two with a white stripe on the forehead and two of uniform gray coloration. Prior to the food preference trial, the animals underwent a seven-day familiarization period, during which they were offered the selected plant species and adapted to the experimental handling. This period aimed to minimize stress, ensure that all individuals recognized the offered food, and standardize trial conditions.

Cafeteria test

The cafeteria or consumption preference test was conducted over 15 consecutive days, during which 1 kg of fresh leaves from six plant species, previously analyzed for chemical composition, was supplied. The species were placed in feeders positioned 5 cm apart, ensuring that the tapirs had simultaneous access to all options. Animals had free access to the forage for three hours each day, after which any uneaten remains were removed and weighed to determine rejection.

Measurement of consumption and rejection

Daily forage consumption for each tapir was determined by subtracting the weight of rejected forage from the initial quantity offered. Results were corrected to account for possible errors or variations in leaf supply. Consumption data were then correlated with the nutritional and chemical composition of the plant species.

To assess forage preference and rejection, the following variables were measured:

- CV: Quantity of forage consumed by each tapir at the end of each day.
- NVCSC: Number of times a tapir visited a feeder without consuming forage.
- NVCC: Number of times a tapir visited a feeder and consumed forage.
- TCEA: Total time a tapir devoted to consuming each plant species.

Statistical analysis

To determine whether significant differences existed among the evaluated variables, an analysis of variance (ANOVA) was applied, followed by Tukey's mean comparison test ($P \leq 0.05$). Statistical analyses were performed using SAS software.

Revista Bio ciencias
ISSN 2007-3380

Results and Discussion

Consumption and rejection

Analysis of consumption and rejection during the cafeteria test revealed that tapirs showed a marked preference for tender plant parts. In the case of *Brosimum alicastrum*, animals primarily consumed leaves, followed by fruit and stems. Several authors note that forage-consuming animals tend to prefer leaves and young stems of shrubs and trees, as these contain higher levels of total digestible nutrients than other species for most of the year and are more readily available than other forage types (Gastelum-Mendoza *et al*., 2024). Additionally, this preference may be related to the internal anatomy of the tapir, considered analogous to that of the domestic horse, with a well-developed cecum capable of fiber and forage degradation. It is also well established that the more digestible the forage, the greater the preference and consumption (González, 2020).

This behavioral result is consistent with previous studies that identify the Maya nut tree as an important food source for herbivores in tropical areas, due to its high protein and energy content (López-Pérez *et al.,* 2012). Preference for the Maya nut tree leaves may be related to their low content of toxic compounds or tannins, which aligns with other studies on tapirs and tropical herbivores that show a preference for young, succulent leaves with lower fiber content (Foerster & Vaughan, 2002). The Maya nut tree fruit is also a valuable energy source, and its consumption may be associated with the need to supplement the diet with carbohydrates during the dry season, when the availability of other food sources declines and the animal's energy demands increase.

Regarding the consumption of papaya and guarumo, both plants are recognized for their high nutritional value. Guarumo, for instance, produces large, tender leaves with low lignin content, which facilitates digestion. Papaya is well known for its high sugar content, which could explain its popularity among tapirs. The consumption of gumbo-limbo, Maya nut tree, and churimo is also noteworthy, since these species are often associated with well-drained soils and form part of the natural habitat of tapirs (Naranjo-Riñera & Cruz-Aldán, 1998; Pérez-Flores *et al*., 2021). Although curly dock is not commonly reported in tapir diets, its inclusion may be explained by its moderate fiber content and seasonal availability during the months of collection.

Collection period and seasonality

The collection period, from October to December, is also relevant since it typically coincides with a decline in food resources in some tropical areas. In this context, it is common for herbivores to broaden their dietary spectrum to include plants that are not necessarily their preferred choice but are available.

Some researchers emphasize that food availability can directly influence forage selection by tapirs, especially when competition with other species occurs or access to preferred foods is restricted. Body size and condition may also play a role: given their large size and high energy requirements, tapirs need to consume between 10 and 15 kg of food per day. They achieve

Revista Bio ciencias
ISSN 2007-3380

this by ingesting small, energy- and protein-rich portions during their peak activity periods, since their stomach capacity is quite limited (Pérez-Flores *et al*., 2024). The findings of this study are fundamental for understanding the feeding preferences of *Tapirella bairdii*, particularly in fragmented or human-modified areas. The conservation of plant species such as *B. alicastrum* and *C. obtusifolia*, which form part of their diet, could be crucial for maintaining healthy tapir populations in both natural habitats and captivity.

Ethogram of tapir feeding activities

Five days of observation revealed that these animals show a strong preference for consuming succulent forage plant species such as the Maya nut tree, guarumo, gumbo-limbo, churimo, curly dock, and papaya, which together represented 82.5 % of their diet. Fruits, by contrast, accounted for only 17.5 % of their total intake. This feeding pattern indicates that tapirs prioritize plants providing greater nutritional benefits, particularly during the daytime period from 12:00 to 15:00 h.

Results also demonstrated that the aforementioned forage species were statistically significant in the tapir diet ($p \leq 0.0001$), which is consistent with studies indicating that these herbivores primarily feed on leaves, stems, and young shoots, especially from plants offering high nutrient content (Naranjo & Bodmer, 2007). The fact that tapirs prefer forage plants over fruits suggests that these species provide a more balanced diet in terms of energy, protein, and minerals. The strong preference for forage species during the day indicates a more efficient feeding strategy, as fruits, while rich in energy, do not supply the fiber content necessary for adequate stomach fill and proper digestion in their digestive system (Dumbá *et al.,* 2022).

Feeding patterns by time of day

The feeding pattern observed between 12:00 and 15:00 h revealed that, although the tapir consumes forage consistently, there was a peak intake between 12:00 and 12:40 h. This behavior may be related to resource availability and the need to meet energetic requirements to achieve optimal thermoregulation during the warmest hours of the day. Previous studies on tapirs suggest that these animals are more actively engaged in feeding during the early afternoon (Foerster & Vaughan, 2002), which is consistent with the pattern recorded in this study. Such feeding behavior could be influenced by environmental factors such as ambient temperature and water requirements, since tapirs have been reported to seek water sources regularly.

The behavior of *Tapirella bairdii* includes key activities such as feeding, hydration, locomotion, and defecation, all of which are linked to the maintenance of metabolism and overall well-being. Water consumption is essential to facilitate the digestion of fiber-rich forage, while locomotion is associated with searching for new sources of food and water, depending on the season. Defecation, in turn, provides an indirect measure of digestive system function and the efficiency of nutrient utilization (Carrillo-Reyna *et al*., 2015).

This ethological analysis has important implications for tapir management and conservation, both in natural habitats and in captivity. Recognizing the most preferred forage species is crucial to ensure that conservation programs focus on preserving these plants in critical areas of their habitat. Moreover, guaranteeing the availability of nearby water sources may help balance forage intake with proper hydration, thereby promoting optimal health in tapirs.

Bromatological analysis of plants

Table 2 presents the results of the bromatological analysis of six forage species used in the captive diet of the tapir. The evaluated components include the percentages of ash, ether extract, acid detergent fiber, neutral detergent fiber, dry matter, and total protein. The most relevant results are described below:

Ash

Gumbo-limbo showed the highest ash content (16.7 ± 1.9 %), significantly higher ($p < 0.0001$) than churimo, which exhibited the lowest value (5.8 ± 1.3 %). This suggests a higher concentration of minerals in gumbo-limbo, which could influence tapir preference for this species at certain times of the year. Ash represents the mineral fraction of forage and may be indicative of calcium, magnesium, and potassium content, which are essential for bone and metabolic health.

Other studies, such as Ángeles-Mayorga *et al*. (2022), reported 11.8 % ash in the same species, whereas our results were higher, possibly due to differences in soil composition or plant maturity at the time of collection. In contrast, Cueyactle-Cano *et al*. (2021) reported only 1.9 % ash in gumbo-limbo, a discrepancy that underscores the importance of ecological and seasonal factors in the nutritional composition of plants. In the case of curly dock, ash content was 12.9 %, lower than the 15.5 % reported by Apráez *et al*. (2014), again highlighting the influence of seasonal and ecological contexts in such studies.

Ether extract

Papaya presented the highest ether extract content (17.58 %), significantly higher ($p < 0.0001$) compared to other species such as curly dock (5.3 ± 1.8 %) and churimo (5.5 ± 1.1 %). This indicates that papaya is an important source of lipids in the tapir diet. This is particularly relevant since lipids are essential for energy supply and the absorption of fat-soluble vitamins. However, previous studies, such as those by Montes Pérez *et al*. (2022) and Cueyactle-Cano *et al*. (2021), reported much lower ether extract values in papaya (2.7 % and 3.5 %, respectively). These differences could be explained by variations in the timing of fruit harvest, as ripe fruits typically contain higher lipid levels than unripe ones. Additionally, papaya ether extract content may vary according to variety and growth conditions, which could account for discrepancies among studies.

Revista Bio ciencias
ISSN 2007-3380

Acid detergent fiber

The highest percentage of acid detergent fiber was found in the Maya nut tree (29.0 ± 3.4 %), significantly different ($p < 0.0181$) from species such as churimo (13.0 ± 2.6 %), gumbo-limbo (13.2 ± 2.6 %), and guarumo (14.0 ± 3.9 %), which showed lower values. ADF represents components such as lignin and cellulose, which are more difficult for herbivores to digest. However, its presence in the diet can contribute to digestive health in tapirs by providing bulk and improving intestinal transit. These values are consistent with studies such as Foerster & Vaughan (2002), who reported that the Maya nut tree is one of the most consumed plants by tropical herbivores due to its year-round availability despite its high fiber content. Nonetheless, other research, such as Ángeles-Mayorga *et al*. (2022), reported much higher ADF values (44.1 %) in the Maya nut tree, which could be attributed to environmental conditions such as seasonality or soil characteristics where the plant grows.

Neutral detergent fiber

Papaya showed the highest percentage of neutral detergent fiber (16.0 ± 5.1 %), significantly different ($p \leq 0.0001$) from other species such as churimo (5.5 %) and Maya nut tree (8.4 %), which displayed lower values of this fibrous fraction. Neutral detergent fiber, which includes components such as cellulose and hemicellulose, is important for forage digestibility. However, in comparison with other studies, these values are much lower. Montes Pérez *et al*. (2022) and Ángeles-Mayorga *et al*. (2022) reported considerably higher NDF values in another species, gumbo-limbo (63.3 % and 45.17 %, respectively), suggesting that local conditions significantly influence fiber composition. Curly dock exhibited an NDF value of 16.4 %, notably lower than the 52 % reported by Apráez *et al*. (2014). Such differences may be explained by plant developmental stage and sampling location across different studies.

Dry matter

Guarumo presented the highest dry matter content (21.0 %), significantly greater ($p < 0.0001$), indicating a higher amount of non-aqueous material, whereas curly dock showed the lowest value (1.5 %), reflecting a higher proportion of water in its composition. This finding is relevant since species with higher water content are often preferred by tapirs during the dry season when access to water sources is limited. The preference for water-rich plants has been previously documented by Bodmer (1990), who also reported that plants with high water content are essential for maintaining herbivore hydration in tropical environments. Similarly, Rojas-Schroeder *et al.* (2017) reported comparable moisture contents for guarumo (10.4 %), confirming its consistently high water availability across environments. However, curly dock displayed a much lower water content (1.5 %) in our study compared to 8.5 % reported by Apráez *et al.* (2014), highlighting notable variations depending on collection site and season.

Revista Bio ciencias
ISSN 2007-3380

Crude protein

Papaya had the highest protein content (15.7 ± 0.5 %), followed by churimo (15.2 ± 0.5 %), while gumbo-limbo showed the lowest (10.3 %). This is relevant because tapirs, although herbivorous, require a considerable amount of protein to maintain metabolic functions and tissue repair. These results align with those of Ayala *et al*. (2006), who found high protein content in the Maya nut tree (14.9 %). In our study, the Maya nut tree presented a lower protein value (11.7 ± 0.6 %), yet it remains an important dietary option during the dry season. In contrast, gumbo-limbo exhibited relatively low protein content (10.3 %), which may explain why, although consumed, it is not particularly preferred in terms of nutritional value. Other studies, such as Cueyactle-Cano *et al*. (2021), also reported low protein percentages for gumbo-limbo (8.9 %), consistent with our findings.

Our results provide valuable insights into the feeding preferences of *Tapirella bairdii* and the nutritional quality of forage species consumed, with significant implications for the management and welfare of individuals in captivity. The greater nutrient availability in species such as the Maya nut tree and guarumo suggests that their inclusion in the diet is essential for maintaining health and body condition in housed tapirs (Sánchez *et al*., 2021). As reported by Foerster & Vaughan (2002), variations in the availability of certain plants during the dry season can directly impact herbivore nutrition, making it a priority to ensure a steady supply of high-nutritional-value forage. The discrepancies observed between our results and those reported by other authors emphasize the influence of local, seasonal, and ecological factors on the chemical composition of plants. This underscores the need for ongoing studies to refine and optimize diets, as well as the design and management of enclosures to support natural behaviors and overall health in tapirs under human care.

Table 2. Percentage composition from the bromatological analysis of six forage species in the captive diet of the tapir.

Species	Ash	EE	ADF	NDF	DM	CP
Guarumbo	15.2 ± 1.3 ^{b}	8.8 ± 1.1 ^{ab}	14.0 ± 3.9 ^{a}	8.8 ± 5.9 ^{a}	21.1 ± 1.2 ^{c}	14.3 ± 0.5 ^{cd}
Churimo	5.8 ± 1.3 ^{a}	5.5 ± 1.1 ^{a}	13.0 ± 2.6 ^{a}	5.5 ± 5.9 ^{a}	11.2 ± 1.2 ^{b}	15.2 ± 0.5 ^{cd}
Curly dock	12.9 ± 1.9 ^{b}	5.3 ± 1.8 ^{a}	16.4 ± 3.9 ^{ab}	9.0 ± 5.9 ^{a}	1.5 ± 1.8 ^{a}	13.0 ± 0.7 ^{bc}
Maya nut tree	14.9 ± 1.7 ^{b}	8.4 ± 1.5 ^{ab}	29.0 ± 3.4 ^{b}	8.4 ± 5.1 ^{a}	10.4 ± 1.2 ^{b}	11.7 ± 0.6 ^{ab}
Gumbo-limbo	16.7 ± 1.9 ^{b}	11.6 ± 1.1 ^{b}	13.2 ± 2.6 ^{a}	11.6 ± 5.9 ^{ab}	8.4 ± 1.2 ^{b}	10.3 ± 0.5 ^{a}
Papaya	11.9 ± 1.9 ^{ab}	17.6 ± 1.1 ^{c}	16.7 ± 3.4 ^{ab}	16.0 ± 5.1 ^{b}	6.7 ± 1.2 ^{b}	15.7 ± 0.5 ^{d}

EE = Ether Extract; ADF = Acid Detergent Fiber; NDF = Neutral Detergent Fiber; DM = Dry Matter; CP = Crude Protein. Different superscript letters within the same column indicate significant differences ($p \le 0.05$).

The nutritional content of forages and their consumption by animals is of particular relevance due to the relationship between the amount of ADF and NDF. For instance, food intake and preference in herbivores are influenced by multiple factors, including fiber content, digestible energy, fat, amino acid composition, gut fill, the physical form of the consumed material, and environmental conditions (Milla-Luna *et al.,* 2021). Moreover, intake largely depends on the availability and quality of food resources in specific seasons (Bobadilla *et al.,* 2020). Animals also tend to select plant parts with higher protein content, as the consumption of protein-rich materials in the wild ensures a higher nutritional value compared to a diet with lower energy content (Crowell *et al.,* 2018).

Variability in the consumption and selection of plant species by tapirs also depends on factors such as phenology and its annual and daily geographic variation. Likewise, climatic events such as El Niño and La Niña may lead to oscillations or changes in both plant growth patterns and animal behavior (Hiyo, 2018). Additionally, it has been reported that food intake is associated with fiber digestibility, which in turn depends mainly on lignin content. This polyphenolic lignocellulosic compound is part of the fiber and binds to cellulose, forming indigestible complexes. The amount of lignin in fiber increases as forage matures; therefore, grasses and forages are more suitable at an early vegetative (tender) stage. Similarly, protein content decreases as plants age and become woody. In ruminants and pseudoruminants such as tapirs, fiber plays an important role in pH regulation; thus, the consumption of immature or succulent forages is prioritized (Pérez & Ricalde, 2022).

Conclusions

The Central American tapir shows a preference for tree forage species in the vegetative stage, characterized by lower ADF and NDF contents and higher protein levels. Although fruit consumption also occurs, it is secondary and limited to specific times of day. The availability of high-quality forage and water is essential for the well-being of these animals. Findings from captive conditions can be applied to management and conservation programs in both holding facilities and wild habitats, ensuring that natural ecosystems provide adequate and sustainable resources for the species.

Leaves of the Maya nut tree were the most consumed by captive tapirs, followed by fruits and stems. Gumbo-limbo stands out for its high ash and ether extract content, while papaya showed the highest NDF content. Regarding ADF and dry matter, the Maya nut tree exhibited the highest levels, and churimo provided the greatest protein content. Plant species consumed by *Tapirella bairdii* display notable differences in nutritional value, which influence feeding preferences. Furthermore, these animals adjust their feeding times and habits based on seasonal availability and forage quality. Although species such as the Maya nut tree and guarumo have high nutritional potential, they are not exclusively indispensable; their inclusion is desirable, but they may be complemented or substituted with other species that meet the tapir's nutritional requirements. This allows for the design of more flexible feeding strategies, contributing to the proper maintenance of captive individuals and the sustainable management of wild populations.

Author contributions

Author 1: Manuscript writing and results analysis; **Author 2:** Field sample collection; **Author 3:** Methodology design; **Author 4:** Laboratory analyses; **Author 5:** Final manuscript preparation and editing.

Funding

This research received no external funding.

Conflict of interest

The authors declare no conflict of interest.

References

Ángeles-Mayorga, Y., Cen-Cen, E. R., Crosby-Galván, M. M., Ramírez-Bribiesca, J. E., Candelaria-Martínez, B., Sánchez-Villarreal, A., & Ramírez-Mella, M. (2022). Foliage of tropical trees and shrubs and their secondary metabolites modify *in vitro* ruminal fermentation, methane and gas production without a tight correlation with the microbiota. *Animals*, 12, 1-19. https://doi.org/10.3390/ani12192628

Apráez G., E., Gálvez, C. A., & Jojoa, R. C. (2014). Valoración nutricional y emisión de gases de algunos recursos forrajeros del trópico de altura. *Revista de Ciencias Agrícolas*, 31 (1), 122–134. doi: http://dx.doi.org/10.22267/rcia.143102.36

Aranda, A. M. (2019). Manual de manejo y sanidad del Tapir centroamericano (Tapirus bairdii) en el Centro de Reproducción Zoo Nicaragua. *Tesis de grado. UNIVERSIDAD NACIONAL AGRARIA. Managua, Nicaragua*. Pp. 115. https://repositorio.una.edu.ni/id/eprint/3880

Ayala, B. A., Cetina G. R., Capetillo L., C. Zapata, C. C., & Sandoval C. C. (2006). Composición química-nutricional de árboles forrajeros. CONACYT-SAGARPA-COFUPRO. 60 Pp. https://www.researchgate.net/publication/277141987_Composicion_Quimica-Nutricional_de_Arboles_Forrajeros

Bobadilla, S.Y., Marchetta A., Dacar M. A., Ojeda R. A., & Cuevas M. F. (2020). Food habits of European rabbit and its role as seed dispersal of two Mosqueta roses: Facilitation among non-native species in a semiarid protected area of Argentina. *Biological Invasions*, 22, 1565-1571. http://hdl.handle.net/11336/142156

Botello, F., Sánchez-Hernández, J., Hernández, O., Reyes-Chávez, D., & Sánchez-Cordero, V. (2014). Registros notables del tapir centroamericano (*Tapirus bairdii*) en la sierra Mixe, Oaxaca, México. *Revista Mexicana de Biodiversidad*, *85*, 995-999. http://dx.doi.org/10.7550/rmb.41024

Carrillo-Reyna, N., Reyna-Hurtado, R., & Schmook, B. (2015). Abundancia relativa y selección de hábitat de Tapirus bairdii en las reservas de Calakmul y Balam Kú, Campeche, México. Revista Mexicana de biodiversidad, 86(1), 202-207. https://doi.org/10.7550/rmb.40247

Crowell, M. M., Shipley, L. A., Forbey, J. S., Rachlow, J. L., & Kelsey. R. G. (2018). Dietary partitioning of toxic leaves and fibrous stems differs between sympatric specialist and generalist mammalian herbivores. *Journal of mammalogy*. 99(3), 565-577. ISSN 0022-2372. https://doi.org/10.1093/jmammal/gyy018

Cueyactle-Cano, H. Y., Serna-Lagunes, R., Mora-Collado, N., Zetina-Córdoba, P., & Torres-Cantú, G. B. (2021). Preferencia de ocho plantas por Odocoileus virginianus en cautiverio. *Revista Mexicana de Ciencias Pecuarias*, 14 (1), 228-236. https://doi.org/10.22319/rmcp.v14i1.5123.

Dumbá, L. C.S., Rodrigues, F. H. G., Maclaren, J. A., & Cozzuol, M. A. (2022). Dental occlusal surface and seed dispersal evolution in Tapirus (Mammalia: Perissodactyla). *Biological Journal of the Linnean Society,* 136(1), 23-40. https://doi.org/10.1093/biolinnean/blac013

Foerster, C. R. & Vaughan, C. (2002). Home range, habitat use and activity of Baird's tapir in Costa. Rica. *Biotropica*, 34(3), 423-437. https://doi.org/10.1646/0006-3606(2002)034[0423:HRHUAA]2.0.CO;2

García, E. (2004). Modificaciones al sistema de clasificación climática de Koppen (para adaptarlo a las condiciones de la República Mexicana). Instituto de Geografía, UNAM. México. 98 p. https://es.scribd.com/document/607657269/Modificaciones-Al-Sistema-Climatico-de-Koppen-Garcia-1964.

García, M., Jordan, C., O'Farril, G., Poot, C., Meyer, N., Estrada, N., Leonardo, R., Naranjo, E., Simons, Á., Herrera, A., Urgilés, C., Schank, C., Boshoff, L. & Ruiz-Galeano, M. (2016). Tapirus bairdii. The IUCN Red List of Threatened Species 2016: e.T21471A45173340.

Gastelum-Mendoza, F. I., Lozano-Cavazos, E. A., González-Saldívar, F. N., Uvalle-Sauceda, J. I., Romero-Figueroa, G., Serna-Lagunes, R., & Cantú-Ayala, C. M. (2024). Estrategias forrajeras del borrego cimarrón (*Ovis canadensis mexicana*) en el noreste de México. *Ecosistemas y Recursos Agropecuarios*, 11(1), 1-5. https://doi.org/10.19136/era.a11n1.3921.

González, G. A. (2020). Inflamación mandibular en el tapir centroamericano (Tapirus bairdii) cambio de dentición y retención de la corona de dientes deciduos como potencial etiología. *Revista de Medicina Veterinaria*, (41), 49-55. https://doi.org/10.19052/mv.vol1.iss41.5

Hiyo, B. L. (2018). Estacionalidad en el uso del hábitat y dieta en una especie en peligro de extinción: Tapirus pinchaque y "Tapir andino", en el Santuario Nacional Tabaconas-Namballe, Cajamarca, Perú.Tesis. Universidad Ricardo Palma, Perú. Pp. 82. https://hdl.handle.net/20.500.14138/1414

Huerta-Rodríguez, J. O., Poot-Sarmiento, I., Duarte-Morales, A., Martínez-Martínez, L. V., & Reyna-Hurtado, R. (2024). Baird's Tapir (Tapirus bairdii) avoid human settlements and roads while searching for water in community-owned forests from the Calakmul region: Tapir's pond use in Calakmul region. *THERYA,* 15(3), 259-259. http://doi.org/10.12933/therya-24-6135

Janzen, D. H. 1983. Tapirus bairdü. Pp. 509-510 in D. H. Janzen (ed.), Historia Natural de Costa Rica. Editorial de la Universidad de Costa Rica, San Pedro de Montes de Oca, Costa Rica. 822 pp. https://www.acguanacaste.ac.cr/historia-natural-costa-rica/Historia-natural-de-Costa-Rica-Editado-por-Daniel-H-Janzen-1991.pdf

López, C. M., Salas, W. F. C., & Andino, N. E. (2022). Especies potenciales para jardines alimenticios de dantos (Tapirus bairdii) en cautiverio. *Portal de la Ciencia*, 1(17), 20-31.

https://doi.org/10.5377/pc.v1i17.16075

López-Pérez, E., Serrano-Aspeitia, N., Aguilar-Valdés, B. C., & Herrera-Corredor, A. (2012). composición nutricional de la dieta del venado cola blanca (Odocoileous virginianus ssp. mexicanus) en pitzotlán, morelos nutritional. *Revista Chapingo Serie Ciencias Forestales y del Ambiente*, 18 (2), 219-229. https://doi.org/10.5154/r.rchscfa2011.01.006

Milla-Luna, M., Cruz-Bacab, L., Ramírez-Vera, S., Arjona-Jiménez, G., & Zapata-Campos, C. (2021). Contenido de proteína y fibra en forrajes tropicales no afecta la preferencia en conejos de engorda. *Abanico veterinario*, 11, 1-7. https://doi.org/10.21929/abavet2021.35

Montes Pérez, J. J., Marcé, R., Obrador, B., Conejo Orosa, T., Díez, J. L. Escot, C., Reyes, I., & Moreno Ostos, E. (2022). Hydrology infuences carbon fux through metabolic pathways in the hypolimnion of a Mediterranean reservoir. *Aquatic Sciences*, 84 (36), 1-16. https://link.springer.com/article/10.1007/s00027-022-00867-2

Naranjo-Riñera, E. J., & Cruz-Aldán, E. (1998). Ecología del Tapir (Tapirus bairdii) en la reserva de la Biosfera La Sepultura, Chiapas, México. *Acta Zoológica Mexicana,* 73, 111–125. https://doi.org/10.21829/azm.1998.73731730

Naranjo, E. J., & Bodmer, R. E. (2007). Source-sink systems and conservation of hunted ungulates in the Lacandon forest, Mexico. *Biological conservation*, 138 (3-4), 412 - 420. https://doi.org/10.1016/j.biocon.2007.05.010

Oliveira, A. K., Matias, M. D., Fernandes, R., & Pina, J. C. (2022). Effect of frugivory on the germination of cumbaru (Dipteryx alata) seeds ingested by tapirs (Tapirus terrestris) in the area of Cerrado, Brazil. *Anais da Academia Brasileira de Ciências*, 94(3),1-15. https://doi.org/10.1590/0001-3765202220211266

Pérez-Flores, J., Mardero, S., López-Cen, A., & Contreras-Moreno, F. M. (2021). Human-wildlife conflicts and drought in the greater Calakmul Region, Mexico: implications for tapir conservation. *Neotropical Biology and Conservation,* 16(4), 539-549. https://doi.org/10.3897/neotropical.16.e71032

Pérez-Flores, J., Sánchez-Hernández, G., & Bahena-Basave, H. (2024). El tapir y los escarabajos peloteros: reforestando México. *Therya ixmana*, 3(1), 23-25. http://doi.org/10.12933/therya_ixmana-24-429

Pérez, C. F. A., & Ricalde, R. S. (2022). Pastos y forrajes para alimentación en caballos. *Bioagrociencias*, 15(2),1-12. https://www.revista.ccba.uady.mx/ojs/index.php/BAC/article/viewFile/4523/1947

Plata, F. X., Ebergeny, S., Resendiz, J. L., Villarreal, O., Bárcena, R., Viccon, J. A. & Mendoza, G. D. (2009). Palatabilidad y composición química de alimentos consumidos en cautiverio por el venado cola blanca de Yucatán (Odocoileus virginianus yucatanensis). *Archivos de medicina veterinaria*, 41(2), 123-129. https://dx.doi.org/10.4067/S0301-732X2009000200005

Rodríguez-López, M. E., Sánchez-Hernández, G., & Gómez, B. (2019). Escarabajos coprófagos (Coleoptera: Scarabaeidae: Scarabaeinae) en la reserva El Zapotal, Chiapas, México. *Revista peruana de biología*, 26(3), 339–350. http://dx.doi.org/10.15381/rpb.v26i3.16778

Rojas-Schroeder, J. A., Sarmiento-Franco, L., Sandoval-Castro, C. A. & Santos-Ricalde, R. H. (2017). Utilización del follaje de ramón (Brosimum alicastrum Swarth) en la alimentación animal. Tropical and Subtropical Agroecosystems, 20(3), 363-371. https://www.redalyc.org/pdf/939/93953814001.pdf

Ruíz, R. (2010). Manual de Prácticas de laboratorio de bromatología MPO-LBR-001. Universidad

Revista Bio ciencias
ISSN 2007-3380

Autónoma de Chiapas, Pp 5-27. https://www.ujat.mx/

Sánchez Gutiérrez, F., Valdez Hernández, J.I., Hernández de la Rosa, P., Sánchez Escudero, J., Sánchez, Ángel-Sol., Castillejos Cruz, C., & Brindis-Santos, A.I. (2021). Estructura y composición arbórea en un gradiente altitudinal del Área Natural Protegida Metzabok, Chiapas, México. *Revista de Biología Tropical*, 69(1), 12-22. http://dx.doi.org/10.15517/rbt.v69i1.40689

Trillanes, C. E., Naranjo, E. J., Ramírez-Marcial, N., Pérez-Jiménez, J. C., Perera-Marín, J. G., Chávez-Hernández, C., & Falconi-Briones, F. (2023). Estimación de la condición corporal del tapir centroamericano (*Tapirus bairdii*) a partir de datos de fototrampeo en la Selva Lacandona, México. Acta universitaria, 33, 1-10. https://doi.org/10.15174/au.2023.3890

Yanez-Montalvo, A., Gaona, O., Águila, B., Arias-Dominguez, N., Falcón, L. I., & Perez-Flores, J. (2021). Tapirus bairdii-associated Fecal microbiome from a critical conservation area: Calakmul, México. Current Microbiology, 78(7), 2648-2659. https://doi.org/10.1007/s00284-021-02531-8