

## Nutritional potential of edible insects endemic to the Sierra de Huehuetla, Hidalgo

## Potencial nutricional de insectos comestibles endémicos de la Sierra de Huehuetla, Hidalgo

Frida Leilani Vázquez-Pérez<sup>a</sup>, Deysi Robles-Ortiz<sup>b</sup>, Armando Pelaez-Acero<sup>a</sup>, Gabriela Medina-Pérez<sup>a</sup>, Antonio Castillo-Martínez<sup>c\*</sup>

### Abstract:

In several regions of the world, insects are a traditional food source. Mexico's rich ecological and ethnic diversity contributes to a cuisine characterized by unique vegetable and animal ingredients. Among these, insects are considered ethnocultural ingredients, and their consumption, known as entomophagy, provides valuable nutrients, including proteins, fats, carbohydrates, fiber, and vitamins. In San Esteban, Huehuetla Hidalgo, collections of edible insects were conducted. The chicatanas ants were collected in June 2021, and milpero grasshoppers during the corn harvest in October 2020. The morphological analysis identified three species: *Atta cephalotes* (red Chicana), *Atta mexicana* (dark chicana), and *Sphenarium sp.* (miller grasshopper). Insects were subjected to "roasting on a comal," a common local practice, and analyzed for their proximate composition. Results showed that *Sphenarium sp.* had the highest protein content (69.24%), compared to *Atta mexicana* (43.73%) and *Atta cephalotes* (41.85%). However, *Atta* ants had significantly higher fat content (>32%) than *Sphenarium sp.* (12.91%).

### Keywords:

protein content, entomophagy, *Sphenarium sp.*, *Atta mexicana*

### Resumen:

En varias regiones del mundo, los insectos son una fuente tradicional de alimentación. En México, su rica diversidad ecológica y étnica contribuye a una cocina caracterizada por ingredientes vegetales y animales únicos. Entre estos, los insectos se consideran ingredientes etnoculturales, y su consumo, conocido como entomofagia, aporta nutrientes valiosos, entre ellos proteínas, grasas, carbohidratos, fibra y vitaminas. En la localidad de San Esteban, Huehuetla, Hidalgo, se realizaron colectas de insectos comestibles. Las hormigas chicatanas se recolectaron en junio de 2021 y los chapulines milperos durante la cosecha de maíz en octubre de 2020. El análisis morfológico identificó tres especies: *Atta cephalotes* (chicatanas roja), *Atta mexicana* (chicatanas oscura) y *Sphenarium sp.* (chapulín milpero). Para evaluar su aporte nutricional, los insectos fueron sometidos a "asado en un comal", una práctica local común, y analizados para determinar su composición próxima. Los resultados mostraron que *Sphenarium sp.* Las hormigas *Atta* presentaron el mayor contenido de proteína (69,24%), en comparación con *Atta mexicana* (43,73%) y *Atta cephalotes* (41,85%). Sin embargo, las hormigas presentaron un contenido de grasa significativamente mayor (>32%) que *Sphenarium sp.* (12,91%). Estos insectos se consumen asados, fritos, en salsas o como botanas con sal y limón, complementando la dieta local durante su disponibilidad en junio y finales de octubre.

### Palabras Clave:

contenido proteico, entomofagia, *Sphenarium sp.*, *Atta mexicana*

<sup>a</sup>Instituto de Ciencias Agropecuarias, Universidad Autónoma del Estado de Hidalgo, Avenida Universidad Km. 1 s/n Ex Hacienda Aquetzalpa, 43600, Tulancingo, Hgo. Gabriela Medina Pérez, [gabriela\\_medina@uaeh.edu.mx](mailto:gabriela_medina@uaeh.edu.mx), <https://orcid.org/0000-0001-8673-941X>; Frida Leilani Vázquez Pérez, [va440549@uaeh.edu.mx](mailto:va440549@uaeh.edu.mx), <https://orcid.org/0009-0004-4885-8265>; Armando Peláez Acero [pelaeza@uaeh.edu.mx](mailto:pelaeza@uaeh.edu.mx), <https://orcid.org/0000-0001-7004-4824>; Deisy Robles Ortiz, <sup>d</sup>Universidad Internacional del Trópico Americano, [deisyrobles@unitropico.edu.co](mailto:deisyrobles@unitropico.edu.co), <https://orcid.org/0009-0000-9760-8992>; <sup>c</sup>Universidad Autónoma Agraria Antonio Narro, Unidad Laguna, Departamento de Parasitología, Antonio Castillo Martínez, <https://orcid.org/0000-0002-8586-4240>. \*Autor de Correspondencia: Email: [acm\\_sultan@hotmail.com](mailto:acm_sultan@hotmail.com)

## **1. Introduction**

Insects are the most successful animal group on the planet due to their biomass, phenotypic plasticity, ecological niche diversity, and global distribution [1]. They represent the largest estimated terrestrial biomass and comprise nearly one million scientifically described species [2]. Additionally, they exhibit high reproductive rates and significant nutritional content [3]. Since ancient times, insects have been a renewable natural resource utilized by various ethnic groups in Mexico, primarily for their gastronomic importance [4, 5]. Due to their distinctive flavor, they are consumed in different preparations, such as roasted, toasted, in tacos, or as part of sauces [4]. This tradition has endured to the present day, establishing itself as a traditional food resource, a source of income, and a cultural element that meets dietary, medicinal, and agricultural needs [6].

Various insects have been part of the diet, including grasshoppers (Acrididae), known by different regional names depending on their geographic location [7, 8]. While they are considered agricultural pests, they also serve as a traditional food source. Similarly, chicatanas a type of edible flying ant—hold ancestral importance in the diet of certain ethnic groups [9, 10].

No studies on entomophagy have been documented in the Otomí-Tepehua region (Hidalgo). Although insect consumption has been observed in the local traditional cuisine, there is a lack of scientific publications supporting this fact. Therefore, this research aimed to determine the protein content of insects collected in San Esteban, Huehuetla Hidalgo, providing a foundation for promoting their consumption as a nutritional supplement in rural communities.

## **2. Materials and methods**

This section considered the research methods and techniques, the context of the study area, the methodology used in the field for data collection, the identification of specimens, and the nutritional analysis carried out in the laboratory.

### **2.1. Area of study**

The Otomí-Tepehua region is located in the southeastern part of the state of Hidalgo, between the Sierra Madre Oriental and the Altiplano of the Valley of Mexico, delimited by the states of Veracruz (N, NE) and Puebla (S, SE); with an area of 778.6 km<sup>2</sup>, its topography includes valleys and mountains with variable altitudes between 300 and 1,600 meters above sea level; its hydrography is composed of springs, rivers and freshwater streams. There is a diversity of microclimates, with a predominance of warm and semi-warm humid climates (Huehuetla, Tenango de Doria), temperate humid climates (Tenango de Doria, San Bartolo Tutotepec), and semi-cold temperate humid climates in Tenango de Doria (SIIIEH, 2012).

The study area where the research was implemented was the town of San Esteban, located in Huehuetla, in Hidalgo. The geographic location of the place of sampling is delimited by longitude 20° 32'40.0, latitude -98° 03' 37.0, and an altitude of 771 meters above sea level. The site is located approximately 9.14 kilometers northwest of the municipal seat called Huehuetla, with a population of 1,645 inhabitants (INEGI, 2020).

The town is located within the physiographic province Sierra Madre Oriental, within the Carso Huasteco subprovince, whose territory is mountainous. Hydrography is positioned in the Tuxpan-Nautla region, within the Tuxpan River basin, and in the Pantepec River sub-basin, determined by a humid semi-warm climate with year-round rain (INEGI, 2020).

The soil that predominates in the study town is semi-desert, with a layer rich in organic matter and nutrients. The land is used for seasonal agriculture and forestry, although it is also used for construction, commerce, and other services. Land ownership is largely ejidal and private property to a lesser extent. The soil is of the Feozem (75%) and Acrisol (25%) type, with a crumb-like texture, black, and with optimal physicochemical conditions for the

development of vegetation; the flora that predominates in the high places is typical of the humid climate, and in the lower parts it is of the tropical type (SNIM, 2002).

## 2.2. Data collection techniques

This study used a quantitative approach to obtain field data. Direct sampling, specimen identification, and nutritional analysis were carried out.

### 2.2.1. Collection

Corn grasshoppers were collected during the corn harvest season (October 2020), and San Juan ants were called "chicatanas" (June 2021). The ethnoecological method (Barrera-Bassols and Toledo, 2005) was followed before capturing the specimens. The purpose of this is to recover the knowledge of the native peoples about the sources of local food, their beliefs, and food customs; local collectors and marketers were identified, those who know about the seasons (presence, emergence, reproduction) and the collection sites where they obtain their products.

anthills, in the yard, and in spaces with public lighting, using an entomological net and a plastic container for storage. The corn grasshoppers were collected in the mornings (7:00-10:00 am) directly in the corn field during the corn cob harvest season. Corn plants were examined for manual and entomological capture. The specimens were stored in a plastic container. Finally, they were placed in glass jars at 4 °C.

### 2.3. Taxonomic identification of insects

The specimens were observed under a stereoscopic microscope (Olympus SZ2- ILST) and were placed in jars with 96% ethanol. Insects were identified using the entomological taxonomic keys of Triplehorn and Johnson [11] at the family level, those of [12] for Formicidae and [13] for Caelifera genera (AntWeb, 2020).

### 2.4. Proximal composition analysis

The specimens were cooked on a griddle at 120°C for 10 minutes and proximately chemically analysed.

Table 1. Proximal composition of endemic edible insects from Huehuetla Hidalgo, Mexico

Samples	Crude Protein (%)	Total fat (Ethereal extract)	Ashes	Crude Fiber	Carbohydrates
<i>Atta mexicana</i>	43.73 <sup>a</sup>	34.15 <sup>a</sup>	4.23 <sup>a</sup>	7.92 <sup>a</sup>	9.97 <sup>a</sup>
<i>Atta cephalotes</i>	41.85 <sup>b</sup>	32.57 <sup>ab</sup>	3.11 <sup>b</sup>	11.74 <sup>b</sup>	10.73 <sup>b</sup>
<i>Sphenarium</i> sp.	69.24 <sup>c</sup>	12.91 <sup>c</sup>	4.39 <sup>ac</sup>	10.15 <sup>c</sup>	2.95 <sup>c</sup>

### 2.2.2. Sampling

The milpa system's anthills and fields in San Esteban, Huehuetla, and Hidalgo were inspected. The direct collection of "Chicana" ants was executed in the early morning when they made their nuptial flight. The capture was carried out manually in the

The composition analysis followed the methodology established by the AOAC (1990). Moisture content (air oven method 964.22), protein N x 6.25 (Kjeldahl method 955.04), fat (Soxhlet extraction method 920.39C), and ash (Muffle incineration method 923.03) were measured. All determinations were performed in triplicate

### 3. Results

Three species of edible insects were identified, traditionally called by local inhabitants as “chícala negra, chícala roja” (chicatana = Formicidae: Hymenoptera: Atta) and “chapulín milpero” (locust = Orthoptera: Caelifera: *Sphenarium*). The specimens were taxonomically identified, resulting in the species *Atta mexicana* (n=34/62), *Atta cephalotes* (n=28/62), and 19 specimens of *Sphenarium sp.*

The content of proteins, total fats, ashes, crude fiber, and carbohydrates was evaluated and reflected in Table 1, and regarding the ants, they are similar to [14]. Grasshopper proximal composition is shown in Table 1. [15] found that *Zonocerus variegatus* showed mean values of 34.85 %, 9.47%, 7.03%, 2.63%, and 86.61% for crude protein, ash content, ether extract, crude fiber, and dry matter respectively. Grasshoppers contain a higher proportion of crude protein than chicatanas, and a similar composition was found in the present study. Fat content was [16] identical to [13]; they reported 31.20-30.10%.



Figure 1. Chícala negra (*Atta mexicana*)



Figure 2. Chícala roja (*Atta cephalotes*).

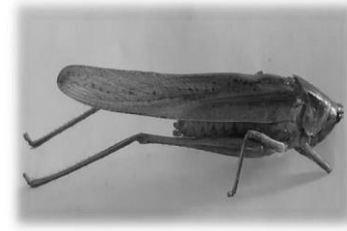


Figure 3. Chapulín milpero (*Sphenarium sp.*)

### 4. Conclusion

This study confirms the high nutritional value of edible insects endemic to the Sierra de Huehuetla, Hidalgo, highlighting their potential as an alternative source of proteins and fats. The results indicate that *Sphenarium sp.* has the highest protein content, while *Atta mexicana* and *Atta cephalotes* contain a higher concentration of fats. These findings support the relevance of entomophagy in rural communities, not only as a gastronomic tradition but also as a food resource with significant nutritional benefits. Integrating these insects into food education and security programs could contribute to diet diversification and the sustainable use of local resources.

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