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Bee pollen from different floral species of the caatinga biome: determination of nutritional parameters

Pólen apícola de diferentes fontes florais da caatinga: determinação de parâmetros nutricionais

Karen Daniele Lima da Costa[1], Maria Carolina de Abreu[2], Sinevaldo Gonçalves de Moura[3], Juliana do Nascimento Bendini[4*]

ABSTRACT: The objective of this work was to characterize nutritional parameters of bee pollens from plant species occurring in a semiarid region, in Picos, state of Piaui, Brazil. Bee pollen samples were collected from the experimental apiary of the Study Group on Bees from the Semiarid Region of Piaui (GEASPI/UFPI) and subjected to melissopalynological analysis to determine their botanical origins, and bromatological analysis (crude protein, lipids, fibers, and ash) in the Laboratory of Animal Nutrition of the Department of Zootechnics of the Federal University of Piaui (UFPI), in Teresina, Piaui (DZO/UFPI/Teresina). Six plant species (*Aspilia* sp., *Senna obtusifolia, Mimosa pudica* L., *Cuphea ericoides*, *Croton* sp., and *Mimosa caesalpiniifolia*) were predominant for bee pollen production in the study area. Therefore, the nutritional compositions of the pollen produced in the Caatinga area varied according to their botanical origin, as shown by the crude protein (20.75% to 38.18%), fiber (0.53% to 1.37%), lipid (0.49% to 4.7%), and total mineral (2.56 to 4.17%) contents. Bromatological parameters also varied according to the botanical origin of the pollens evaluated. The study region has considerable diversity of pollinator plant species that provide bee pollens with a wide spectrum of nutritional characteristics.

KEYWORDS: Beekeeping; botanical diversity; nutritional value.

RESUMO: O objetivo do trabalho foi caracterizar, por meio de parâmetros nutricionais, amostras de pólen apícola provenientes de espécies vegetais ocorrentes em uma região semiárida, no município de Picos, Piauí. As amostras de pólen apícola foram coletadas do apiário experimental do Grupo de Estudos sobre Abelhas do Semiárido Piauiense (GEASPI/UFPI) e submetidas: 1. à análise melissopalinológica para a determinação das origens botânicas; e 2. às análises bromatológicas (proteína bruta, lipídeos, fibras e cinzas) no Laboratório de Nutrição Animal do Departamento de Zootecnia (DZO/UFPI/Teresina). Constatou-se que existem seis espécies (*Aspilia* sp., *Senna obtusifolia, Mimosa pudica* L., *Cuphea ericoides*, *Croton* sp. e *Mimosa caesalpiniifolia*) vegetais predominantes na produção de pólen apícola na área de estudo e assim, o pólen apícola produzido em uma área de Caatinga do município de Picos apresentou composição nutricional que variou de acordo com sua origem botânica: teor de proteína bruta (20,75 a 38,18%), a quantidade de fibras (0,53 a 1,37%), o teor de lipídeos (0,49 a 4,7%) e a quantidade de minerais totais (2,56 a 4,17%). Observou-se que os parâmetros bromatológicos do pólen apícola variaram de acordo com a origem botânica do produto. Concluiu-se que a região apresenta considerável diversidade de espécies vegetais poliníferas que concedem ao pólen apícola um amplo espectro de características nutricionais.

PALAVRAS-CHAVE: apicultura; diversidade botânica; valor nutricional.

[1 e 4] Universidade Federal do Piauí, *campus* Senador Helvídio Nunes de Barros
[2] Universidade Federal do Piauí, *campus* Ministro Petrônio Portela
[3] Universidade Federal do Plauí, *campus* Cinobelina Elvas
*Corresponding author: karendaniele265@gmail.com
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INTRODUCTION

Piaui is the largest honey producing state in the Northeast region of Brazil (IBGE, 2021) and most beekeepers are in the Caatinga biome (MELQUÍADES; BENDINI; MOURA, 2020). Steppe savanna is the predominant vegetation, which as twelve recognized typologies that present different adaptations to semiarid habitats, resulting in a rich biodiversity that characterizes it as the most biodiverse semiarid region in the world (SEYFFARTH; RODRIGUES, 2017).

Botanical diversity has impacts on beekeeping in this ecosystem. BENDINI et al. (2021) mapped apiaries and bee flora of a semiarid region of the state of Piaui and found that the maintenance of a dense Caatinga vegetation positively impacts the productivity of hives.

According to FRIAS et al. (2016), plant species provide necessary elements to bees, mainly pollen and nectar. The nectar collected by bees supplies the carbohydrate needs of their colonies, whereas the pollen supplies their need for proteins, minerals, amino acids, lipids, and vitamins (WRIGHT; NICOLSON; SHAFIR, 2018).

DONKERSLEY et al. (2017) reported that the greater the botanical diversity of the pollen stored by bees, the greater the nutritional contribution to the colony. This diversity can be evaluated through analysis of pollen grains collected by bees, which provides important information on the floral resources of an area (BISILIK et al., 2008).

According to OCHUNGO et al. (2021), an adequate pollen supply determines the colony population growth; thus, information on the plant species visited by bees is important for the development of beekeeping, especially in semiarid regions, where extensive drought periods are marked by scarcity of available flower resources. Therefore, the objective of the present study was to characterize the nutritional composition of bee pollens, according to their botanical origin, in an area of the Caatinga biome in Picos, Piaui, Brazil.

MATERIAL AND METHODS

Frontal-type pollen collectors were installed in five hives of Africanized bees (*Apis mellifera* L.) at the Experimental Apiary of the Study Group on Bees from the Semiarid Region of Piaui, of the Federal University of Piaui (GEASPI/UFPI), in an area of the Caatinga biome in the municipality of Picos, state of Piaui, Brazil (07°04'37"S, 41°28'01"W).

Pollen was daily collected from each hive during most of the rainy season (February to May), which corresponds to the period of greatest floral diversity in the semiarid region (ALEIXO et al., 2014; BENDINI et al., 2021). The collected samples were dehydrated in a biological oven at 40 °C for 48 hours, subsequently separated by color, identified according to the collection date, and stored in plastic containers in a freezer at -20 °C.

Melissopalynological analysis was carried out by direct preparation of pollen slides, in triplicate, with no use of the acetolysis method. Twenty-five balls of different colors from 2 grams of each sample, mixed with distilled water, were used (BARTH, 1989; MORETI et al., 2002). A minimum of 300 pollen grains were counted in the triplicate, and the pollen types of each slide were identified according to the reference palynotheque of the GEASPI/UFPI. The predominance was determined according to Louveaux, Maurizio; Vorwohl (1978), who considered dominant the pollen that has an occurrence greater than 45%.

The slide collection of pollen grains from plants visited by *Apis mellifera* L. bees in the region of Picos composes the palynotheque of the GEASPI/UFPI, which currently has 40 bee plant species, with their pollen grains described in terms of scope, shape, size, ornamentation, and number of openings.

Bromatological analysis (crude protein, lipids, and ash) was carried out at the Laboratory of Animal Nutrition of the Department of Zootechnics of UFPI, (DZO/UFPI), in Teresina, Piaui, according to the methodology described by AOAC (1995). The results were transferred to spreadsheets (Microsoft Office Excel® 2016) and descriptively analyzed.

RESULTS

The results of the melissopalynological analysis of pollen samples showed predominance of six pollen types referring to plant species that supply pollen to bees in the area evaluated. The amounts of pollen collected according to the period (months) of pollen availability of each botanical species are represented in Figure 1.

The results showed that the pollen of *Aspilia* sp. (Asteraceae) was the most representative of the bee pollen production, contributing with 670.4 g from April to May, followed by *Senna obtusifolia* (L.), H. S. Irwin; Barneby (Fabaceae) (650 g in March), *Mimosa pudica* L. (Fabaceae) (356.7 g in February), *Cuphea ericoides* Cham. & Schlech (Lythraceae) (247.75 g in March and April), *Croton* sp. (Euphorbiaceae) (182.6 g in February), and *Mimosa caesalpiniifolia* Benth. (Fabaceae) (137.5 g in February and March). The results found for nutritional characteristics by the bromatological analysis of each pollen type are shown in Table 1.

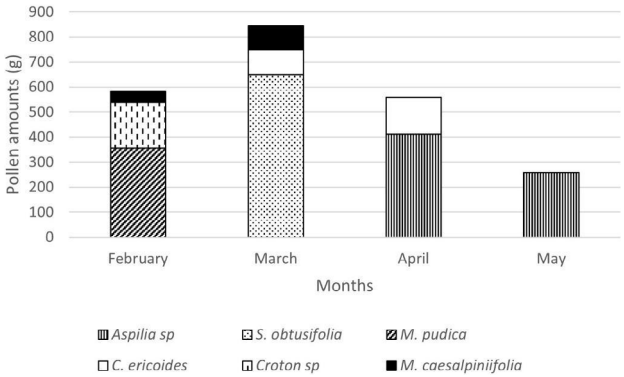

Figure 1. Months of pollen collection by bees per botanical species.

Table 1. Nutritional characteristics of bee pollen samples from the predominant botanical species.

Pollen type	Amount collected (g)	Crude protein (%)	Crude fiber (%)	Lipids (%)	Ash (%)
Aspilia sp. (Asteraceae)	670.40	20.75	0.84	1.0	2.83
Croton sp. (Euphorbiaceae)	183.60	22.26	0.53	4.70	2.69
Cuphea ericoides Cham. & Schlech (Lythraceae)	247.75	33.46	0.73	0.49	3.84
Mimosa caesalpiniifolia Benth. (Fabaceae)	132.59	21.91	1.09	1.88	2.56
Mimosa pudica L. (Fabaceae)	356.74	38.18	1.71	3.71	4.17
Senna obtusifolia (L.) H.S.Irwin & Barneby (Fabaceae)	650.00	19.61	1.37	4.31	2.62

DISCUSSION

Despite the significant floral diversity in the Caatinga biome, where species bloom mainly during the studied period in the present work, the bees were concentrated on six plant species to compose their pollen loads. Similar results were found by BISILIK et al. (2008), who reported that bees concentrate on few plant species to collect floral resources even in environments with a diverse vegetation. Floral constancy is well described in several studies since Aristotle (GRÜTER; RATNIEKS, 2011).

February and March present greater diversity of botanical species composing the largest amounts of pollen collected by bees, corroborating the results found by BENDINI et al. (2021) in a survey of bee flora in a semiarid region of Piaui.

The floral preferences of many pollinating insects are adjusted based on floral cues learned during foraging, since the olfactory experiences from the foraging context are important for honey bees when searching for pollen (ARENA; FARINA, 2014). However, COOK et al. (2003) emphasized that the preferences of bees seem to be connected to the pollen nutritional quality. Although not fully known, these preferences are learned by foraging bees, especially for pollen collection (NERY; MORENO; ARENA, 2020).

The results of the present study showed that a greater amount of monofloral bee pollen from *Aspilia* sp. and *Senna obtusifolia* was collected by the bees. These samples had lower nutritional compositions, quantitatively, than those from the other species, which had higher protein, lipid, mineral, and fiber contents, indicating that bees may consider the presence of other nutrients to collect pollen, such as amino acids (COOK et al., 2003), in addition to factors connected to floral biology, such as flowering time, pollen availability in anthers, anther types, number of stamens, and time and duration of anthesis. Therefore, future studies on floral biology and amino acid contents are needed to better understand bee preferences for pollen collection.

The current Brazilian legislation (BRASIL, 2001) establishes physicochemical parameters for the bee pollen produced in the country. The pollen samples analyzed in the present study showed lower fiber contents than the minimum established (2%) by this legislation. However, NICOLSON (2011) reported that availability of nutrients in pollen depends on the ease of digesting them; thus, the low fiber contents found in the present study for the pollen samples in the Caatinga biome probably has positive implications for bees regarding facilitation of digestion and assimilation of nutrients.

The lipids and ash contents were consistent with those established by the current Brazilian legislation. The ash content expresses the total amount of minerals in a sample, which may vary according to the floral origin; moreover, the mineral content is not dependent on the soil type, but on the plant species (KOSTIĆ et al., 2015). It is consistent with the results found in the present study, as the samples were collected in a same area and presented variations in mineral contents (2.65% to 4.17 %) that are connected only to the floral origins of the pollen collected.

MARTINS et al. (2011), PINTO et al., (2012), BARRETO et al., (2012), and MUNIZ et al. (2020) analyzed crude protein contents in bee pollen samples from different regions of Brazil and found means ranging from 12.28% to 27.07%; higher crude protein contents (26.03±7.79%) were found in the present study for the semiarid region of Piaui, ranging from 19.61 to 38.18%.

Lipids, as well as proteins, is important for the development of bee colonies. According to CANAVOSO et al. (2001), lipids are involved in production of cuticular hydrocarbons and wax, behavioral maturation in adults, diapause, learning, and development of glands that produce food for the offspring. The bee pollen samples analyzed in the present study showed significantly lower lipid amounts (0.49 to 4.70%) than those found by MARTINS et al. (2011) for bee pollen from different regions of the country (4.01 to 13.32%). In addition, bee pollen from *Aspilia* sp. and *Cuphea ericoides* showed lower lipid contents than those established by the Brazilian legislation.

DONKERSLEY et al. (2017) reported that the combination of pollens from different plants is important to ensure the colony nutrition. Thus, although the present study was focused on analyzing monofloral pollen loads collected by bees, there is a dynamic composition of nutrients taken to the colonies that encompasses the diverse botanical species used for pollen collection.

The dry period in semiarid regions of the state of Piaui lasts approximately six months; during this period, the availability of food resources for bees is scarce (NOVAIS; LIMA; SANTOS, 2010). In addition, the high temperatures and low relative air humidity make it difficult for worker bees to maintain the hive microclimate (RIBEIRO et al., 2019). Considering that the success of thermoregulation is connected to the colony nutritional supply (TAUTZ et al., 2003), information on nutritional contents in the pollen available during the flowering season is one of the determining factors for the maintenance of colonies during the dry period in semiarid regions, since beekeepers can preserve and even spread botanical species in regions surrounding their apiaries.

CONCLUSION

Six plant species were predominant for bee pollen production in the Caatinga biome area evaluated in Picos, Piaui, Brazil, and *Aspilia* sp. was quantitatively the most important. The nutritional compositions of bee pollens produced in the area varied according to their botanical origin, presenting higher protein contents than those found in the literature.

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