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Environment

Plants, pests, and ants: ethnoknowledge of countryside communities on vegetable gardens

Plantas, pragas e formigas: etnoconhecimentos de comunidades rurais sobre hortas

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RESUMO

Hortas são importantes para a manutenção da segurança alimentar e biodiversidade. Particularmente para insetos, a presença de espécies nas hortas é definida por métodos tradicionais de controle aplicados de geração a geração e ligados aos conhecimentos tradicionais das comunidades. Neste contexto, nós objetivamos identificar os conhecimentos de comunidades rurais sobre hortas familiares, relacionados aos vegetais cultivados, principais pragas dos vegetais, seus métodos de controle e o papel das formigas nestes ambientes. Nós entrevistamos 46 famílias de cinco comunidades rurais de Santa Rita de Caldas, Minas Gerais, Brasil. Entre elas, 44 famílias reportaram ter ou ter tido hortas em suas residências. Poucas etnoespécies de vegetais são frequentemente cultivados (especialmente, alface e couve). As famílias têm amplo conhecimento sobre métodos alternativos para o controle de pragas. Sobre formigas, as comunidades geralmente as consideram apenas como pragas dos vegetais. Neste contexto, estratégias para resgatar o conhecimento tradicional e disseminá-lo entre as comunidades tradicionais é essencial para a preservação da cultura regional e para a conservação da agrobiodiversidade.

Palavras-chave: Etnoentomologia; Etnomirmecologia; Cultura regional

ABSTRACT

Vegetable gardens are important for the maintenance of food security and biodiversity. This is particularly true for insects, as the presence of species in vegetable gardens is defined by traditional control methods that have been applied for generations and are linked to the knowledge of traditional communities. In this context, we aimed to identify the knowledge of rural communities regarding family vegetable gardens, including the vegetables cultivated, the main vegetable pests, their control methods, and the role of ants in these environments. We interviewed 46 families from five rural communities in Santa Rita de Caldas, Minas Gerais, Brazil. Among them, 44 families reported that they currently have or have had a vegetable garden at their residence. A limited number of vegetables from ethnospecies are commonly cultivated, primarily lettuce and kale. The families possess a broad knowledge of alternative pest control methods. Regarding ants, the communities generally view them only as pests to vegetables. In this context, strategies to preserve traditional knowledge and disseminate it among traditional communities are essential for the preservation of the regional culture and the conservation of agrobiodiversity.

Keywords: Ethnoentomology; Ethnomyrmecology; Regional culture

1 INTRODUCTION

Family vegetable gardens are a traditional practice adopted by people who live in countryside or peri-urban areas. This intergenerational practice primarily led by women involves cultivating numerous species of plants near their homes to meet the dietary, medicinal, and religious needs of their families (Mafra & Stadtler, 2007; Cambruzzi & Rubim, 2013). In Brazil, family vegetable gardens are vital for the survival of numerous families (Amorozo, 2002; Pereira et al., 2017). This is particularly true for families living in rural areas, for whom products from vegetable gardens represent their primary source of food and means of generating income. Another important aspect of horticultural practices is that they ensure food security for these families (Altieri, 2004), and due to the variety of vegetables cultivated they provide highly nutritious food with minimal use of agrochemicals (Pessoa & Schuch, 2010; Canedo-Júnior et al., 2020; Sousa et al., 2020). In an ecological context, family vegetable gardens can be a complex system due to the diversity of cultivated plants, and the presence of several other organisms, especially insects (Zalazar & Salvo, 2007; Galluzi et al., 2010; Agbogidi & Adolor, 2013). Most of these organisms are beneficial for the maintenance of vegetable gardens, either by providing regulating services (pollination and biological control) or supporting services (nutrient recycling) (Noriega et al., 2018). In addition, vegetable gardens provide conditions and resources to sustain numerous species, making the relationship between humans and vegetable gardens crucial for local biodiversity conservation (Mohri et al., 2013).

On the other hand, as some species in vegetable garden attack plants, and consequently, decrease production or make vegetables less attractive, sometimes making consumption unviable, they may be considered by people as pests in this system (Hill, 1987; Michereff-Filho et al., 2009). Among such pests, insects are the most frequent in vegetable gardens, represented by aphids, caterpillars, grasshoppers, beetles (both larvae and adults) and ants (Clemente et al., 2012; Jesus, 2021). Likewise, slugs and snails are non-insect pests commonly found attacking plants in vegetable gardens (Clemente et al., 2012). For this reason, families have developed various methods for pest control over generations, such as the use of extracts from vegetation growing near their homes.

Since the 1960's, with the implementation of governmental incentive policies in Brazil, the use of pesticides has increased exponentially, and consequently, small farmers adopted these products to control pests in their fields (Londres, 2011). Subsequently, in case of some family vegetable gardens, pesticides have been used in parallel with traditional practices to reduce plant pest infestations. The use of these pesticides is particularly concerning because family garden owners usually lack the expertise to handle these products which leads to health risks (Londres, 2011; Michereff-Filho & Michereff, 2017). Another issue is the incorrect application of the product due to the misclassification of the target pests (Zuch & Silveira-Neto, 2012). In fact, people often associate insects with negative emotions, such as fear, repulsion and disgust or believe that they cause damage to their family's belongings (Silva & Costa-Neto, 2004; Jorge et al., 2014). Consequently, people frequently misidentify insects or even non-insect animals as pests (Costa-Neto & Resende, 2004; Moraes & Alves, 2013; Moraes et al., 2017). Among these misclassified taxa are spiders (Class Arachnida), snails (Class Gastropoda), earthworms (Class Clitellata), frogs (Class Amphibia), rats (Class Mammalia), and snakes (Class Reptilia). As a result of this, family garden owners usually resort to the use of broad-spectrum pesticides which can harm both pests and non-pest organisms, leading to biodiversity loss, a decrease in natural control, pollinators mortality and soil, and water contamination (Mahmood et al., 2016).

Among the insects found in vegetable gardens, ants are frequently reported as pests (Valadares & Pasa, 2010; Boff et al., 2011; Valadares & Pasa, 2012; Moraes et al. 2017). Several ant species inhabit horticultural environments, and due to their diverse habitats and behaviors, they interact in various ways with cultivated plants and other organisms present in these ecosystems (Edwards, 2016; Vandermeer et al., 2002). Although ants are typically considered only as pests in family gardens, they can also play significant roles in various ecological processes that benefit the productivity of cultivated vegetables through biological control and nutrient cycling (Evans, et al., 2011; Edwards, 2016). Thus, the issue of labeling all ants (and other insects) as pests by families can result in the elimination of beneficial ants from the vegetable garden. In this context, understanding the diversity of ants, their interactions and control methods in family vegetable gardens is closely tied to the knowledge of rural countryside communities rather than being solely a taxonomic matter. Therefore, comprehending, appreciating and integrating traditional knowledge into agricultural practices is highly significant in stablishing socio-environmental strategies for sustainable rural development.

In this context, we aimed to assess the traditional knowledge of rural communities regarding the maintenance of family vegetable gardens, including the vegetables cultivated, the primary vegetables pests, and the methods used for pest control. We also sought to understand the perspective of these communities regarding the role of ants in horticultural environments. Specifically, we were interested in learning whether the ant-aphid interaction is among the behaviors cited by community members since this interaction can occur on various cultivated plants in vegetable gardens and intensify the damage caused by aphids to plants, thereby compromising vegetable production (Renault et al., 2005; Wu et al., 2014; Levan & Holway, 2015).

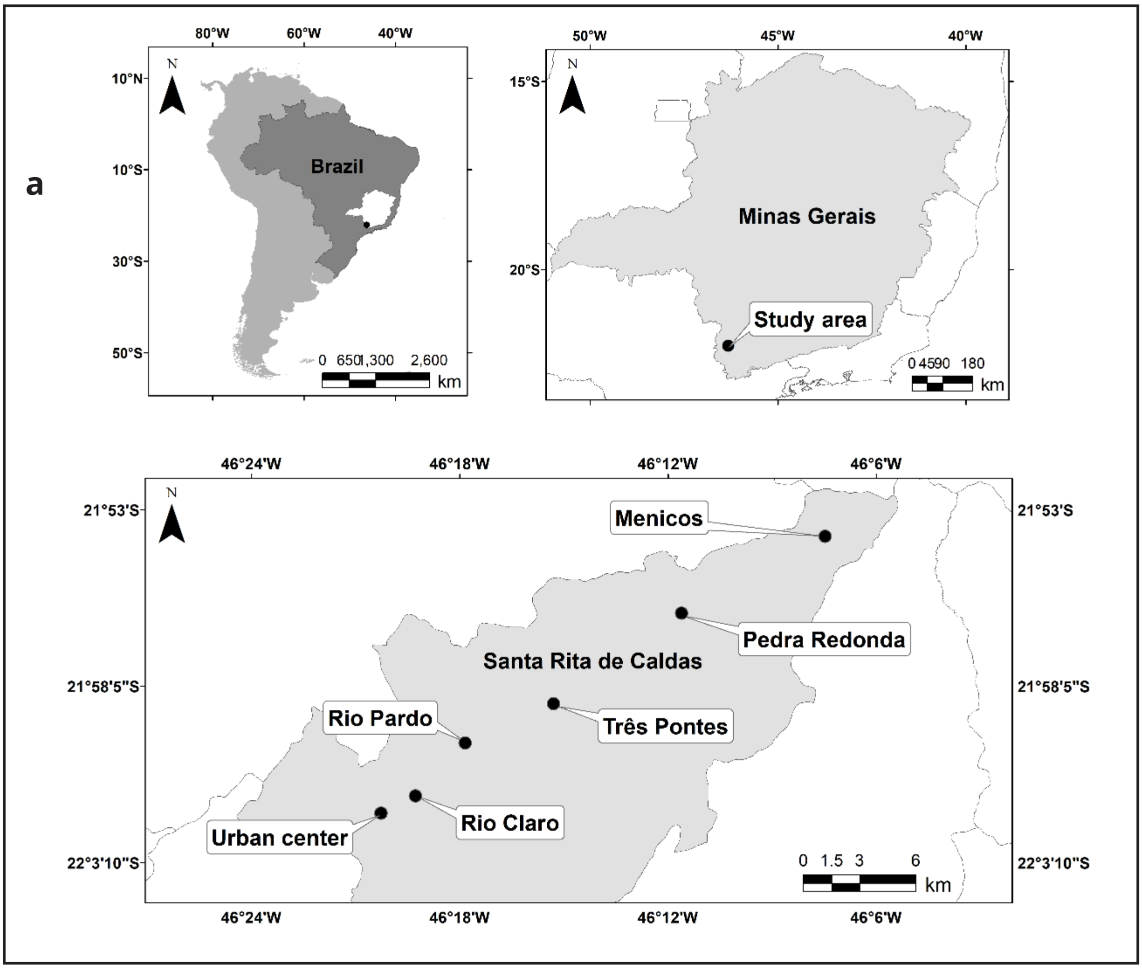
2 MATERIALS AND METHODS

We conducted the study in July 2015 in Santa Rita de Caldas, located in southern Minas Gerais, Brazil. This small city is home to approximately 10 thousand inhabitants. The municipality's economy is primarily based on agricultural activities, including family farming and dairy farming (IBGE, 2018).

We received assistance from Mr. Ernesto de Oliveira Canedo in selecting the communities that participated in our study. Mr. Canedo is a resident of Santa Rita de Caldas and worked for 34 years along the rural roads of the city, providing him with extensive knowledge of the countryside communities in the area. Mr. Canedo's involvement was of vital importance for the development of our work due to the trust that families in the communities placed in him. Having individual integration into the community's experiences facilitated our approach to the families and increased the reliability of the responses of the interviewees (Albuquerque et al., 2010; Bisol, 2012). Mr. Canedo led us to the most distant community from the urban center (via roads), which served as our starting point. While returning towards the urban center, we recorded the locations of other communities we encountered. For the study, we selected only communities composed of at least ten families. By the end of the route, we had identified five communities: Rio Claro, Rio Pardo, Três Pontes, Pedra Redonda and Menicos. We chose communities varying in distance from the urban center to obtain a more representative sample (Figure 1).

We conducted interviews using a questionnaire containing 14 open-ended questions, which had been previously approved by the Ethical Committee of Universidade Federal de Lavras (Document number 1.126.821). The questions were categorized into four parts: I) interviewee identification; II) characterization of the vegetable garden; III) a list of vegetable garden pests and their control methods; and IV) a list of ants and their behavior present in the vegetable garden (see Appendices 1). To identify all the households in the community, we received assistance from families we interviewed, who suggested other families living nearby that we could also interview, following a snowball sampling technique (Albuquerque et al., 2010). Before applying the questionnaire, we introduced the project to the families, and those who agreed to participate signed a consent form. Each interview was conducted by two researchers, with one questionnaire per family.

Figure 1 – Study area in Santa Rita de Caldas, Minas Gerais, Brazil



Source: Authors (2018). Study area in Santa Rita de Caldas, Minas Gerais, Brazil. The five rural communities studied are: Rio Claro, Rio Pardo, Três Pontes, Pedra Redonda and Menicos

2.1 Data Analyses

To establish an ethnographic profile of the five communities, we calculated the arithmetic means and relative frequencies for the interviewee identification data. For the characterization of the family vegetable gardens, we employed the Relative

Frequency of Citation (RFC) method (Parthiban et al., 2016) for various aspects, including the number of vegetables cultivated, the number of reported pests, the types of pest control methods used, and the ant species richness reported. We categorized the vegetables reported based on their use by the families into three groups: conventional plants (CP), unconventional food plants (UFP), and medicinal plants (MP). Conventional plants refer to those widely cultivated, commercialized, and consumed throughout the country, while unconventional food plants include cultivated or spontaneous plants with unique processing methods, typically lacking market value or being commercialized on a small scale (Kinupp & Lorenzi, 2014). Medicinal plants are those possessing therapeutic properties or exerting beneficial pharmacological effects on the human or animal body (Namdeo, 2018). We referred to Kinupp and Lorenzi, (2014) for assessing UFP reports and Lorenzi and Matos (2002) for cheking MP reports. To understand the families' knowledge of pests, the responses to the question "What do you consider a pest?" were categorized by using non-aprioristic content analysis method (Bardin, 1977; Franco, 1986; Campos, 2004). The resulting categories were then ranked using RFC. We grouped the data for the variable 'pest control methods reported' into four categories: alternative methods (methods that utilize natural products or products not originally intended for this purpose); commercial pesticides (products sold in specialized agricultural inputs shops); natural enemies (organisms serving as biological controls); and mystical/religious methods (methods involving religious or mystical rituals).

As the main objective of our study was to assess knowledge related to vegetable gardens, it was not possible to verify the identification of the mentioned plants and pests. This limitation arose because the questions allowed for responses based on both past and present experiences with vegetable gardens. Consequently, many of the interviewees did not currently have vegetable gardens at the time of the interview, but they possessed extensive knowledge on horticultural practices due to past experiences.

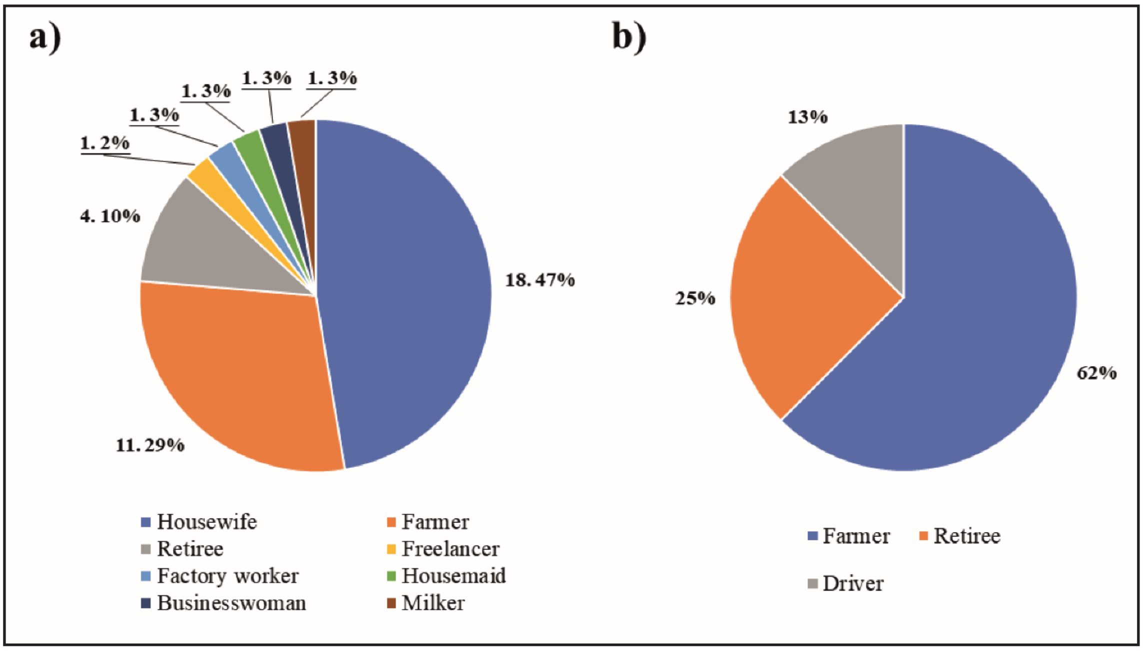
3 RESULTS

3.1 Ethnographic profile

We visited 59 families in the five communities selected for the study; however, 13 of the families declined to participate in the survey. As a result, we interviewed a total of 46 families. A significant portion of those who declined to participate in the interviews (22%) made this decision after the presentation and explanation of the consent form (TCLE), primarily due to the requirement to provide official document numbers and to sign the form.

Among the 46 interviewees, 82% were women with a mean age of 47 years (s.d. ± 14.77) while 18% were men with a mean age of 58 years (s.d. ± 18.16). The three most frequent occupations among women were housewives (47%), farmers (29%) and retirees (11%) (see Fig. 2). For men, only three occupations were mentioned: farmers (63%), retirees (25%) and drivers (13%) (see Fig. 2). The average length of residence in the community was 25 years (s.d. ± 20.86).

Figure 2 – Interviewees occupations



Source: Authors (2018). Relative frequency of the occupations reported by (a) women and (b) men interviewed

3.2 Characterization of family vegetable gardens

Among all the interviewees, 95.6% reported having or having had a vegetable garden at their residence. However, out of the two respondents who reported never having had a vegetable garden, one of them still answered all the questions about vegetable garden management. The interviewees reported a total of 60 different ethnospecies of vegetables cultivated in the gardens, including food and medicinal plants. The Relative Frequency of Citation (RFC) analysis revealed that the three most cited vegetables were lettuce (*Alface*) (RFC = 0.96), kale (*Couve*) (RFC = 0.93), and chives (*Cebolinha*) (RFC = 0.48) (see Table 1). Although family gardens showed a high total diversity of vegetable (60 ethnospecies), 66.6% of these species had a citation frequency below 10% (RFC < 0.1), and 43% of these species had only one citation (RFC = 0.02). In fact, only Alface and Couve occurred in more than 50% of the citations (see Table 1). We didn't have direct contact with the cultivated plants, for this reason basing on the description of the plants by the interviewees, we pointed possible genus/species for the cited plants. We classified 21 possible botanic families, and over 50% of the citations belonged to Solanaceae (9), Cucurbitaceae (7), Apiaceae (6), Brassicaceae (5), Asteraceae (4), and Laminaceae (4). When we assessed the consumption type of the vegetables, we noted that 81.6% were conventional plants (CP), 5% were unconventional food plants (UFP) and 16.7% had medicinal uses (MP). All the interviewed families reported using the vegetable gardens for self-consumption production.

Table 1 – Ranking of vegetables cultivated in the family vegetable gardens according to Relative Frequency of Citation (RFC) analysis

(Continue)

Vegetable name	Possible taxon	Uses*	Number of Citations	Relative Frequency of Citation
Lettuce (Alface)	*Lactuca sativa* L.	CP	44	0.96
Kale (Couve)	*Brassica oleracea* L.	CP	43	0.93
Chives (Cebolinha)	*Allium* sp.	CP	22	0.48
Beet (Beterraba)	*Beta vulgaris* L.	CP	18	0.39

Table 1 – Ranking of vegetables cultivated in the family vegetable gardens according to Relative Frequency of Citation (RFC) analysis

(Continuation)

Vegetable name	Possible taxon	Uses*	Number of Citations	Relative Frequency of Citation
Cabbage (Repolho)	*Brassica oleracea* L. var. *capitata* L.	CP	18	0.39
Tomato (Tomate)	*Solanum lycopersicum* L.	CP	13	0.28
Mint (Hortelã)	*Mentha* sp. L.	MP	12	0.26
Carrot (Cenoura)	*Daucus carota* L.	CP	11	0.24
Parsley (Salsinha)	*Petroselinum crispum* (Mill.) Fuss	CP	10	0.22
Endive (Almeirão)	*Cichorium intybus intybus* L.	CP	7	0.15
Broccoli (Brócolis)	*Brassica oleracea* L. var. *italica* Plenck	CP	7	0.15
Scarlet eggplant (Jiló)	*Solanum gilo* Raddi	CP	7	0.15
Zucchini (Abobrinha)	*Cucurbita* sp. L.	CP	6	0.13
Sorrel (Azedinha)	*Rumex acetosa* L.	UFP	6	0.13
Lemongrass (Erva-cidreira)	*Cymbopogon citratus* (DC.) Stapf.	MP	6	0.13
Casasva (Mandioca)	*Manihot esculenta* Crantz	CP	6	0.13
Arrugula (Rúcula)	*Eruca vesicaria* (L.)	CP	6	0.13
Chayote (Chuchu)	*Sechium edule* Swartz.	CP	5	0.11
Rue (Arruda)	*Ruta graveolens* L.	MP	5	0.11
Spinach (Espinafre)	*Spinacia oleracea* L.	CP	5	0.11
Pepper (Pimenta)	*Capsicum* sp.	CP	4	0.09
Okra (Quiabo)	*Abelmoschus esculentus* (L.) Moench.	CP	4	0.09
Coriander (Coentro)	*Coriandrum sativum* L.	CP	3	0.07
Cucumber (Pepino)	*Cucumis sativus* L.	CP	3	0.07
Onion (Cebola)	*Allium cepa* L.	CP	3	0.07
Lemon balm (Melissa)	*Melissa officinalis* L.	MP	3	0.07
Anise (Erva-doce)	*Pimpinella anisum* L.	MP	2	0.04
Endive (Chicória)	*Chichorium* sp.	CP	2	0.04
Cauliflower (Couve-flor)	*Brassica oleracea* L. var. *botrytis* L.	CP	2	0.04
Ginger (Gengibre)	*Zingiber officinale* Roscoe	CP	2	0.04
Yam (Inhame)	*Dioscorea* sp.	CP	2	0.04

Table 1 – Ranking of vegetables cultivated in the family vegetable gardens according to Relative Frequency of Citation (RFC) analysis

(Continuation)

Vegetable name	**Possible taxon**	**Uses***	**Number of Citations**	**Relative Frequency of Citation**
Radish (Rabanete)	*Raphanus sativus* L.	CP	2	0.04
Parsley (Salsa)	*Petroselinum* sp.	CP	2	0.04
String bean (Vagem)	*Phaseolus vulgaris* var. *vulgaris*. L.	CP	2	0.04
Basil (Manjericão)	*Ocimum basilicum* L.	CP/ MP	1	0.02
Pineapple (Abacaxi)	*Ananas comosus* (L.) Merril.	CP	1	0.02
Italian pumpkin (Abóbora-italiana)	*Cucurbita* sp. L.	CP	1	0.02
Chard (Acelga)	*Beta vulgaris* L. var. *cicla*	CP	1	0.02
Rosemary (Alecrim)	*Rosmarinus officinalis* L.	CP/ MP	1	0.02
Garlic (Alho)	*Allium sativum* L.	CP	1	0.02
Sweet potato (Batata-doce)	*Ipomoea batatas* (L.)	CP	1	0.02
Eggplant (Berinjela)	*Solanum melongena* L.	CP	1	0.02
Pea (Ervilha)	*Pisum sativum* L.	CP	1	0.02
Guiné	*Petiveria* sp.	MP	1	0.02
Herb (Erva)	Unknown	-	1	0.02
Orange (Laranja)	*Citrus sinensis* L. Osbeck	CP	1	0.02
Lemon (Limão)	*Citrus* sp.	CP	1	0.02
Maxixo	*Cucumis anguria* L.	CP	1	0.02
Peruvian parsnip (Mandioquinha)	*Arracacia xanthorrhiza* Bancroft	CP	1	0.02
Corn (Milho)	*Zea mays* L.	CP	1	0.02
Mogango pumpkin (Mogango)	*Cucurbita* sp.	CP	1	0.02
Nevalgina	*Achillea millefolium* L.	MP	1	0.02
Peixinho	*Stachys* sp.	UFP	1	0.02
Chilli pepper (Pimenta-malagueta)	*Capsicum frutescens* sp.	CP	1	0.02
Bell pepper (Pimentão)	*Capsicum annuum* L.	CP	1	0.02
Small plant (Planta-miúda)	Unknown	-	1	0.02
Pennyroyal (Poejo)	*Mentha pulegium* L.	MP	1	0.02
Tamarillo (Tomate-jiló)	*Solanum betaceum* Cav.	UFP	1	0.02

Table 1 – Ranking of vegetables cultivated in the family vegetable gardens according to Relative Frequency of Citation (RFC) analysis

(Conclusion)

Vegetable name	Possible taxon	Uses*	Number of Citations	Relative Frequency of Citation
Cherry tomato (Tomate-cereja)	*Solanum lycopersicum* L. var. *cerasiforme*	CP	1	0.02
String bean (Vagem-de-cerca)	*Faseolus* sp.	CP	1	0.02

* Unconventional food plants (UFP); Conventional Plant (CP); and Medicinal Plant (MP)

Source: Authors (2018)

3.3 Pest ethnospecies and methods for their control

As a result of the content analysis, we classified the answers about the definition of pests into 10 categories. The most frequent category was "Herbivory" (RFC = 0.76), followed by "Unviability of production" (RFC = 0.13) and "Ecological aspects" (RFC = 0.06) (see Table 2). The majority of the interviewees were able to provide a definition of pests in some way (91.3%).

The interviewees reported 26 different pest control methods, distributed among four categories as follows: alternative methods (20); commercial pesticides (2); natural enemies (2); and mystical/religious methods (2). The three most frequently reported methods belonged to the alternative methods category: ashes (*Cinzas*) (RFC = 0.43), tobacco (*Fumo*) (RFC = 0.24), and the extraction or infested or damaged leaves (*Arrancar a folha*) (RFC = 0.22). The fourth most cited pest control method, granulated insecticide (specific for ants) (*Veneno granulado*) (RFC = 0.20), was from the commercial pesticides category (see Table 4).

Table 2 – Ranking of the categories defined by content analysis from the answers on "pests definition" according to Relative Frequency of Citation (RFC) analysis

Category	**Description**	**Number of citations**	**Relative Frequency of Citation**
Herbivory	Damage to leaf tissues (e.g. to cut the leaves, curled leaves)	13	0.76
	Consumption of all parts of the plant (e.g. attack the plants, attack the roots)	17	
	Kill the plant	5	
Unviability of production	Some conditions that make unviable the production or consumption of the plants	6	0.13
Ecological aspects	Some aspect linked to pest density and behavior	4	0.06
Negative feelings	Feeling of disgust related to pests	3	0.05
Alien weeds	Described or cited weeds as pests	3	0.05
Management	Management issues (e. g. inadequate irrigation)	3	0.05
Fungal diseases in plants	Cited leaf rust or fungus	3	0.05
Citation of pest species	Cited examples of pests but without a definition (e.g. aphids, ants)	2	0.04
Religious aspects	Related to the presence of pests to deities	1	0.02
Did not define	People who have not defined pests	4	0.06

Source: Authors (2018)

Table 3 – Ranking of pest ethnospecies in the family vegetable gardens according to Relative Frequency of Citation (RFC) analysis

(Continue)

Ethnospecies	**Possible taxon**	**Number of Citations**	**Relative Frequency of Citation**
Aphids (Pulgão)	Insecta: Hemiptera: Sternorrhyncha	36	0.78
Caterpillar (Lagartas)	Insecta: Lepidoptera (immature stage)	25	0.54
Leafcutter ant (Formigas cortadeiras)	Insecta: Hymenoptera: Formicidae	12	0.26

Table 3 – Ranking of pest ethnospecies in the family vegetable gardens according to Relative Frequency of Citation (RFC) analysis

(Conclusion)

Ethnospecies	Possible taxon	Number of Citations	Relative Frequency of Citation
Snail and Slug (Caramujos e Lesmas)	Gastropoda	10	0.22
Fungus (Fungo)	Fungi	3	0.07
Cricket (Grilo)	Insecta: Orthoptera	2	0.04
Little yellow beetle (Besourinho-amarelo)	Insecta: Coleoptera	1	0.02
Broca	Insecta: Coleoptera	1	0.02
Coró	Insecta: Coleoptera (immature stage)	1	0.02
Fire ant (Formiga-lava-pé)	Insecta: Hymenoptera: Formicidae	1	0.02
Little worm (Minhoquinha)	Unknow	1	0.02
Stink bug (Percevejo)	Insecta: Hemiptera	1	0.02
Woodlouse (Tatuzinho)	Isopoda	1	0.02

Source: Authors (2018)

Table 4 – Ranking of the pest control methods reported, according to Relative Frequency of Citation (RFC) analysis

(Continue)

Pests control methods	Method category	Number of citations	Relative Frequency of Citation
Ashes (Cinzas)	Alternative	20	0.43
Tobacco (Fumo)	Alternative	11	0.24
Extraction of the leaf (Arrancar a folha)	Alternative	10	0.22
Granulated insecticide (Veneno granulado)	Commercial pesticide	9	0.20
Watering (Aguagem)	Alternative	5	0.11
Manual pest collection (Coleta manual da praga)	Alternative	5	0.11
Detergent (Detergente)	Alternative	4	0.09
Sodium hypochlorite (Água sanitaria)	Alternative	3	0.07
Alcohol (Álcool)	Alternative	3	0.07
Pesticide spray (Veneno spray)	Commercial pesticide	3	0.07
Melia azedarach L. seeds (Contas de Santa Bárbara)	Alternative	2	0.04

Table 4 – Ranking of the pest control methods reported, according to Relative Frequency of Citation (RFC) analysis

(Conclusion)

Pests control methods	Method category	Number of citations	Relative Frequency of Citation
Ladybird (Joaninha)	Natural enemy	2	0.04
Milk (Leite)	Alternative	2	0.04
Ruta graveolens L. (Arruda)	Alternative	1	0.02
Blessing (Benzimento)	Mystical / Religious	1	0.02
Calcare (Calcário)	Alternative	1	0.02
Garlic peel (Casca de alho)	Alternative	1	0.02
Onion peel (Casca de cebola)	Alternative	1	0.02
Creolin (Creolina)	Alternative	1	0.02
Cow manure (Esterco de vaca)	Alternative	1	0.02
Washing powder (Sabão em pó)	Alternative	1	0.02
Brine (Salmoura)	Alternative	1	0.02
Superstition rituals (Simpatia)	Mystical / Religious	1	0.02
Cow urine (Urina de vaca)	Alternative	1	0.02
Wasp (Vespa)	Natural enemy	1	0.02
Vinegar (Vinagre)	Alternative	1	0.02

Source. Authors (2018)

3.4 Ant ethnospecies and their behaviors

Four interviewees reported that there were no ants in their vegetable garden. The majority of interviewees classified ants as a pest (82.6%), primarily due to the damage they cause to vegetables. Only one interviewee reported benefits of ants for vegetable garden production, including soil fertilization and predation on other insects. Another interviewee reported a health benefit of ants, inhaling formic acid to alleviate sinusitis.

The interviewees reported a total of eight ant ethnoespecies, with the most cited being *Cortadeira*, *Cabeçuda* or *Saúva*, followed by *Lava-pé* and *Doceira*. Based on the ecological characteristics reported for these ethnoespecies, we attempted potential identifications to the genus or species level and calculated the RFC (see Table 5). Out of the eight ethnospecies reported, *Miudinha-vermelha* and *Pretinha* remained with unclear identifications.

Table 5 – Ranking of ant ethnospecies reported, according to Relative Frequency of Citation (RFC) analysis. Possible species and/or genus of ants was based on the characteristics reported in the interviews

Ethnospecies	Number of Citations	Relative Frequency of Citation	Possible Species and/or Genus
Cortadeira, Cabeçuda or Saúva	17	0.37	*Atta* sp.
Lava-pé	11	0.24	*Solenopsis invicta Buren*, 1972
Doceira	4	0.09	*Camponotus vittatus* Forel, 1904
Monte-de-cisco or Quenquém	3	0.07	*Acromyrmex* sp.
Baúva	1	0.02	*Camponotus rufipes Fabricius*, 1775
Correição	1	0.02	*Labidus* sp. *or Eciton* sp.
Miudinha-vermelha	1	0.02	Unknown
Pretinha	1	0.02	Unknown

Source: Authors (2018).

When asked about ant behavior in the vegetable gardens, 65% of the interviewees reported behaviors that had a negative impact on vegetable production and characterized these behaviors mainly by using the verbs to cut (the leaves) and to carry (the leaves). Only three interviewees reported the presence of the ant-aphid ecological interaction in the vegetable garden, and one person cited ants acting as predators of other insects.

4 DISCUSSION

In our study we found that traditional knowledge about vegetable gardens in these communities continue to persist across generations. However, the gardens have shown a predominance of conventional plants within their vegetable diversity. The concept of pest in these communities is closely linked to the type of damage caused to the plants. Alternative control methods are the primary approach used to prevent and manage pests in these gardens. Nevertheless, when it comes to ants, chemical pesticides are the major method of control. Ants are predominantly considered pests by the interviewed families, with this negative perspective stemming from the misclassification of all ants within the ethnospecies group of leafcutter ants.

4.1 Characterization of family vegetable gardens

As a prominent feature of family vegetable gardens in the studied communities, the majority of individuals interviewed in our study were women (83%), and they hold the knowledge of traditional horticultural practices. During our visits, we observed that when the subject of our survey was raised, women were designated to respond to the questions, even when men were present in the households. Men often stated: the woman is the one who knows about vegetable garden matters. This observation aligns with the findings of Mafra and Stadtler (2007), Cambruzzi and Rubim (2013) and Caballero-Serrano et al. (2019), who demonstrated that culturally women are traditionally responsible for cultivating and managing vegetable garden production. Another noteworthy aspect is that most of the women interviewed were housewives. Housewives typically spend a significant amount of their time at home, allowing them to dedicate a portion of this time to the development and transmission of traditional knowledge in vegetable garden management, in order to provide their families with food and medicinal care (Silva et al., 2006; Silva et al., 2014; Novianti et al., 2017; Manopo et al., 2018).

Regarding the vegetable survey, we found a wide variety of ethnospecies (60) being cultivated when considering all communities. However, when we consider the frequency with which each ethnospecies was reported, 43% were cited only once, and 66.6% had a frequency below 10%. This low overlap of plants usage by the families can also indicate a high diversity of ethnobotanical knowledge within the community. Only two ethnospecies were reported in more than 50% of the interviews: lettuce (*alface*) and kale (*couve*) (see Table 1). We believe that lettuce was the most cited plant because its seedlings are easily found in farming shops, its cultivation is relatively simple, they grow rapidly, and they can be cultivated throughout the entire year in the study region (Makishima, 1993). Kale was the second most cited ethnospecies, being a much-appreciated component of many regional culinary recipes. The success of this plant can be attributed to its flavor, high nutritional value, relatively long life, and high productivity with little management required (Makishima, 1993). The ease of access to these two products may explain the high percentage of conventional plants (CP) mentioned (81.6%), which are generally easier to find and cultivate. Furthermore, unconventional food plants (UFP) that grow spontaneously in the vegetable garden may not be considered as one of the cultivated plants by some interviewees. In terms of medicinal plant (MP) diversity in the vegetable gardens, other studies have shown that communities have cultivated fewer medicinal plants, which could be related to the ease of accessing allopathic medicines (Pinto et al., 2006; Neto et al. 2014; Caballero-Serrano et al., 2019). Despite the low ethnospecies diversity per family, the high frequency of vegetable garden among the communities (95%) demonstrated that these traditional practices continue to persist over time in these communities even under urbanization pressures. The low frequency of vegetables reported by families in this study (7.3 plants) may indicate a reduction in biodiversity associated with horticultural systems. Indeed, having only a few types of vegetables in a garden provides a limited range of conditions and resources to support a more diverse insect community (Benton et al., 2003; Wickramasinghe et al., 2004). Moreover, the four most frequently cited vegetables are consumed before reaching the flowering stage, which means there are limited resources available for omnivorous insects (Coll & Guershon, 2002). Insects like ants or parasitoid wasps are predators, but during parts of their life cycle, they require resources such as nectar and/or pollen (Patt et al., 1997; Billy & Krimmel, 2011).

This reduction in beneficial insects could reduce the potential biological control, and consequently, increase the presence of pests in these systems (Thrupp, 2000; Douglas et al., 2014). Therefore, the negative perspective on insects among rural families may be reinforced, as only a few generalist species (i.e., pests) are consistently found in their vegetable gardens.

4.2 Vegetable pest ethnospecies and methods for their control

The number of pests ethnospecies (13) was low compared to the number of plants ethnospecies reported (60). This result corroborates the study of Bentley (1989), who demonstrated that, in general, traditional communities possess more knowledge about plants than animals. This observation is understandable, as knowledge about the plants in vegetable gardens holds greater importance to the survival of these families than knowledge about the animals residing there. Furthermore, a single ethnospecies may encompass several different taxonomic species, as the communities tend to categorize ethnospecies based on utility or significance rather than adhering to strict taxonomic criteria (Costa-Neto & Pacheco, 2004; Santos-Fita & Costa-Neto, 2009; Petiza et al., 2013).

When we analyzed the responses to the question “What is a pest for you?” we observed that the category “Herbivory” was the most cited (76%) (see Table 2). For most families, the term “pest” primarily pertains to the damage inflicted on parts or the entire plant by pests rather than the insects themselves. In our study, aphids and caterpillars emerged as the two most commonly cited pest ethnospecies, even though they encompass numerous species. It is important to notice that these two groups cause similar damage to plants, primarily herbivory. Leading the communities to classify them as a single ethnospecies. Another critical factor to consider is that these two frequently mentioned pests play a significant role in the cultivation of the two most frequently reported vegetables: lettuce (Colariccio & Chaves, 2017) and kale (Trani et al., 2015). Consequently, understanding pests in these communities is intertwined with their familiarity with these vegetables. Given that lettuce and kale are the most extensively cultivated vegetables among the families in all the communities, the families tend to acquire more knowledge about these plants and, consequently, about the pests affecting them, as these pests are prevalent in nearly all vegetable gardens. Therefore, the understanding of pests in vegetable gardens may have regional nuances and is closely linked to traditional knowledge related to local food production.

The majority of the cited pest control methods belonged to the category of alternative methods, with the most cited method being the use of ashes. The use of ashes for pest control has been previously reported (Valadares & Pasa, 2010). Additionally, this practice is widely adopted by other communities for purposes such as soil fertilization (Neves et al., 2013) and in the preparation of a type of soap known as ashes soap (*sabão de cinzas*) (Pinheiro & Giordan, 2010). The second most cited method was the use of tobacco, a well-known bioinsecticide commonly used in organic agriculture due to its ease of availability, cost-effectiveness, and efficiency in pest control (Andrade & Nunes, 2001; Valadares & Pasa, 2010). Other alternative methods reported include manual extraction of infested or damaged leaves and manual removal of the pests themselves. These methods are straightforward and efficient, however, the extraction of infested or damaged leaves may result in the loss of plant parts that could otherwise be consumed.

Commercial pesticides were also mentioned, with one of them, formicide granulated baits, ranking as the fourth most cited method for pest control. Formicide granulated bait is used to manage leafcutter ants and is easily available in agricultural supply stores. However, it is concerning that none of the interviewees reported receiving guidance or supervision from agricultural professionals regarding the application of this insecticide. The improper use of pesticides can have adverse effects on the health of farmers (Londres, 2011; Huyen et al., 2020). Also, it may pose risks to non-target arthropods (Plentivich et al., 2010; Kenko et al., 2022). Furthermore, it can impact other organisms vital for vegetable production, including pollinators (Goulson et al., 2015), biological control agents (Talebi et al., 2008), and soil engineers (Yasmin & D'Souza, 2010).

4.3 Ants ethnospecies and their behaviors

Regarding the role of ants, most of the interviewees reported that ants are primarily considered as vegetable pests. This result aligns with other studies that have identified ants as among the most frequently cited and significant pests in family farming (Valadares & Pasa, 2010; Santos et al., 2015; Moraes et al., 2017; Novato et al., 2020). This pattern can be attributed to the cultural norms within traditional communities, which usually does not acknowledge the potential benefits of insects (Macedo & Soares, 2012; Jorge et al., 2014).

Only one interviewee reported ants to be beneficial to vegetable gardening, as they play a role in soil fertilization. This interviewee stated, "the leafcutter ant cultivates the soil, where it disturbs making a good product" (Mr. J.M.F., 66 years old). This is consistent with Santos et al. (2015), who noted that interviewees usually do not recognize the ecological importance of ants. Some ants were also cited as having potential health benefits. For instance, the *Baúva* ant, known for its strong odor, is inhaled to help treat sinusitis (S.C.A., 72 years old). The use of ants for medicinal purposes has been reported in other studies as well, with communities using ants from the genus Atta to treat sore throats (Alves et al. 2015), ants from the subfamily Ponerinae for addressing asthma and back pain (Costa-Neto & Resende, 2004), and the stings of Dinoponera grandis to alleviate joint and menstrual pain (Botelho & Weigel, 2011). Inhaling formic acid from Baúva ants, likely of the species Camponotus rufipes, for the treatment of sinusitis and nasal congestion is a common practice in rural communities within the studied municipality (Personal communication with Mr. Canedo).

Despite the high species diversity of ants that can be found in vegetable gardens, only eight ethnospecies were reported in our survey. Even though it is possible that one ethnoespecies may represent multiple taxonomic species, the number of ants ethnospecies reported remains relatively small in comparison to the potential variety of ants species that could inhabit vegetable gardens. Valadares and Pasa (2012) also reported that typically have knowledge limited to ants that directly impact their lives, whether positively or negatively. The most cited ethnospecies belong to the genus *Atta*, as these ants are known for damaging vegetables and their characteristic of moving in organized lines, making them more visible to people. The second most cited ant ethnospecies was *Lava-pé*, which likely refers to *Solenopsis invicta*. The frequent reports about this ant are likely due to its painful sting and its prevalence in open areas with high management activity, such as vegetable gardens (Morrison et al., 2004). The third most cited ant ethnospecies was *Doceira*, which probably refers to ants belonging to *Camponotus vittatus*. These ants are relatively large and are commonly found in kitchens and the surroundings of homes (Soares et al., 2006; Ferreira-Châline & Châline, 2007).

Regarding ant behaviors, most of the interviewees reported only those associated with losses in vegetable farming. This can be attributed to the pervasive presence of leaf-cutting ants, which are known for their ability to cut and transport a large number of plant fragments (Della-Lucia & Oliveira, 1993; Della-Lucia, 2011), making their activities easily observable. In this context, behaviors of ants that have a negative impact on vegetable production may overshadow behaviors that actually benefit vegetables, especially those that are less visible. These beneficial behaviors could include actions related to nutrient cycling process and biological control.

Even the ant-aphid interaction, which is considered a major concern for organic agricultural practices (Delabie, 2001), was not mentioned by most of the families interviewed. Only three interviewees demonstrated some knowledge of this interaction in the vegetable garden. One of these believed that the interaction starts when ants lay eggs on the plant and aphids emerge from these eggs. He explained, “A little black ant climbs and lays some small eggs and seems to produce some kind of fungus. They say the ant goes after the aphids.” - Mr. C.A.O. 36 years old. Another interviewee was uncertain about the nature of the interaction, whether it was mutualistic or predatory.

She said, "There's a little black ant that I don't know if it kills or protects the aphid." – Mrs. A.A.B., 40 years old. Moraes et al. (2017) reported that interviewees often associate ants with the appearance of fungi among the vegetables, categorizing them as the ants responsible for fungus, representing the ant-mealybug interaction. This suggests that traditional knowledge tends to focus more on the consequences of the interaction for the plant rather than the specifics of the interaction itself, such as which organisms are involved or whether it is mutualistic or predatory. Only one interviewee expressed a comprehensive understanding of the ant-aphid interaction, providing details about the ant's behavior: "The aphid, the ant grabs it and feeds on its feces and takes care of it, and even builds a little soil house for it." – J.M.F., 66 years old. In this context, the ant-aphid interaction does not appear to be a significant concern in the studied vegetable gardens, as the interviewees had limited knowledge about it. This observation may be attributed to the gregarious behavior of aphids, which tend to disperse when plants are disturbed during garden management, causing the aphid-tending ants to leave the plants (Canedo-J*únior*, et al., 2018). As a result, people typically only noticed the aphids on the plants and attribute any damage to the vegetables solely to them.

5 CONCLUSION

Our research reveals that the studied communities cultivate a high diversity of plants, and our study also demonstrates that these communities possess extensive knowledge of alternative pest control methods. However, when it comes to dealing with leafcutter ants, they exclusively rely on commercial pesticides, which poses risks to both the health of the families and the environment. The communities we visited have limited knowledge about ant diversity, behaviors, and their ecological significance. This knowledge is important as it can enhance the understanding of the actual roles of ants in vegetable gardens, potentially facilitating sustainable management practices. This, in turn, could lead to reduce costs associated with pesticides, as certain ant species can serve as effective biological control agents while also contributing to improved soil structure and fertilization through their ground nesting ant nests. Strategies aimed at preserving traditional knowledge and sharing it within these traditional communities are essential not only for the preservation of regional rural culture and the conservation of agrobiodiversity, but also to bolster food security for these families.

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