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Analysis of pesticide residues in food in Ceará from 2018 to 2023

Análise de resíduos de agrotóxicos em alimentos no Ceará de 2018 a 2023

Análisis de residuos de plaguicidas en alimentos en Ceará entre 2018 y 2023

Pedro Iori Vale de Carvalho [1]
0009-0006-5383-3606

Bruno Lemos de Oliveira [2]
0009-0002-2803-1207

Sarah Ellen da Paz Fabrício [3]
0009-0000-4891-8951

Tereza Emanuelle da Silva Costa [1]
0009-0000-1624-2985

Rosimary da Silva Barbosa [4]
0000-0001-8895-1481

[1] *Escola de Saúde Pública do Ceará. Fortaleza, Ceará, Brasil.*

[2] *Vigilância Sanitária do Estado do Ceará. Fortaleza, Ceará, Brasil.*

[3] *Universidade Estadual do Ceará. Fortaleza, Ceará, Brasil.*

[4] *Secretaria Municipal de Saúde de Itaiçaba. Itaiçaba, Ceará, Brasil.*

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ABSTRACT

Objective: To identify pesticide residues present in food products sold in the state of Ceará, highlighting products with the highest quantity of different types of residues. **Methods:** Microdata provided by the Sanitary Surveillance Coordination of Ceará, derived from reports from the 2018/2019, 2022, and 2023 cycles of the Pesticide Residue in Food Analysis Program, were used. The data were analyzed for the presence or absence of residues, the result of the report (satisfactory/unsatisfactory), and the sample (regular/irregular). **Results:** 54.3% of the samples were unsatisfactory in 2018/2019; 65.6% in 2022, and 64,9% in 2023. Foods with the greatest diversity of pesticide residues were grapes (26 different residues in 2018/2019), bell peppers (23 residues in 2022), and tomatoes (29 residues in 2023). **Conclusion:** This reinforces the monitoring needs of these substances use, considering risks to public health, as well as the risk of combining different types of residues in the same food.

Keywords: *Maximum waste limit; Sanitary Surveillance; sanitary inspection.*

RESUMO

Objetivo: Identificar resíduos de agrotóxicos presentes em alimentos comercializados no estado do Ceará, destacando produtos com maior quantidade de tipos de resíduos distintos. **Métodos:** Microdados cedidos pela Coordenadoria de Vigilância Sanitária do estado do Ceará, derivados de laudos dos ciclos 2018/2019, 2022 e 2023 do Programa de Análises de Resíduos de Agrotóxicos em Alimentos, foram analisados quanto a presença ou não de resíduos, resultado do laudo (satisfatório/insatisfatório) e da amostra (regular/irregular). **Resultado:** 54,3% das amostras estavam insatisfatórias em

2018/2019; 65,6% em 2022, e 64,9% em 2023. Alimentos com presença de maior diversidade de resíduos de agrotóxicos foram uva, (26 resíduos distintos em 2018/2019), pimentão (23 resíduos em 2022) e tomate (29 resíduos em 2023). **Conclusão:** Reforça-se a necessidade de acompanhamento do uso destas substâncias, considerando os riscos à saúde populacional, além do risco da combinação de diferentes tipos de resíduos em um mesmo alimento.

Palavras-chave: *Limite máximo de resíduos; Vigilância Sanitária; fiscalização sanitária.*

RESUMEN

Objetivo: Identificar residuos de plaguicidas presentes en productos alimenticios comercializados en Ceará, destacando los productos con mayor cantidad de diferentes tipos de residuos. **Métodos:** Se analizaron microdatos proporcionados por la Coordinación de Vigilancia Sanitaria de Ceará, derivados de los informes de los ciclos 2018/2019, 2022 y 2023 del Programa de Análisis de Residuos de Plaguicidas en Alimentos. Los datos se analizaron en cuanto a la presencia/ausencia de residuos, el resultado del informe (satisfactorio/insatisfactorio) y la muestra (regular/irregular). **Resultados:** 54,3% de las muestras fueron insatisfactorias en 2018/2019; 65,6% en 2022 y 64,9 % en 2023. Alimentos con mayor diversidad de residuos de plaguicidas fueron uvas (26 residuos diferentes en 2018/2019), pimientos morrones (23 residuos en 2022) y tomates (29 residuos en 2023). **Conclusión:** Esto refuerza necesidad de vigilancia de estas sustancias, considerando riesgos para la salud pública, así como el riesgo de combinar diferentes tipos de residuos en un mismo alimento.

Descriptores: *Límite máximo de residuos; Vigilancia Sanitaria; inspección sanitaria.*

INTRODUCTION

Since 2008, Brazil has been the world's largest consumer of pesticides, data that is evidenced by the Food and Agriculture Organization and the Brazilian National Cancer Institute[1,2]. These chemical products are used to mitigate or eliminate pests, accelerate production and minimize losses, but they can cause harm to the health of consumers and agricultural workers, especially when there is an absence or incorrect use of personal and collective protective equipment, generating serious risks to the lives of these professionals[3].

Pesticides are classified according to their active ingredient and purpose. Herbicides combat weeds; insecticides act against insects; fungicides against fungi; acaricides against mites and rodenticides against rodents[4]. Among the active ingredients of pesticides: Mancozeb: an antifungal that inhibits the proliferation of fungi; Imidacloprid and Dichlorodiphenyltrichloroethane (DDT), both insecticides; DDT, although widely used in the past, is associated with cancer and has a degradation time of up to 30 years[5]. Its prohibition in Brazil occurred through Law No. 11,936/2009[6]; Glyphosate: the most widely used herbicide in the country[7], associated with risks of cancer, fetal malformation and reduction of the pollinating bee population[8].

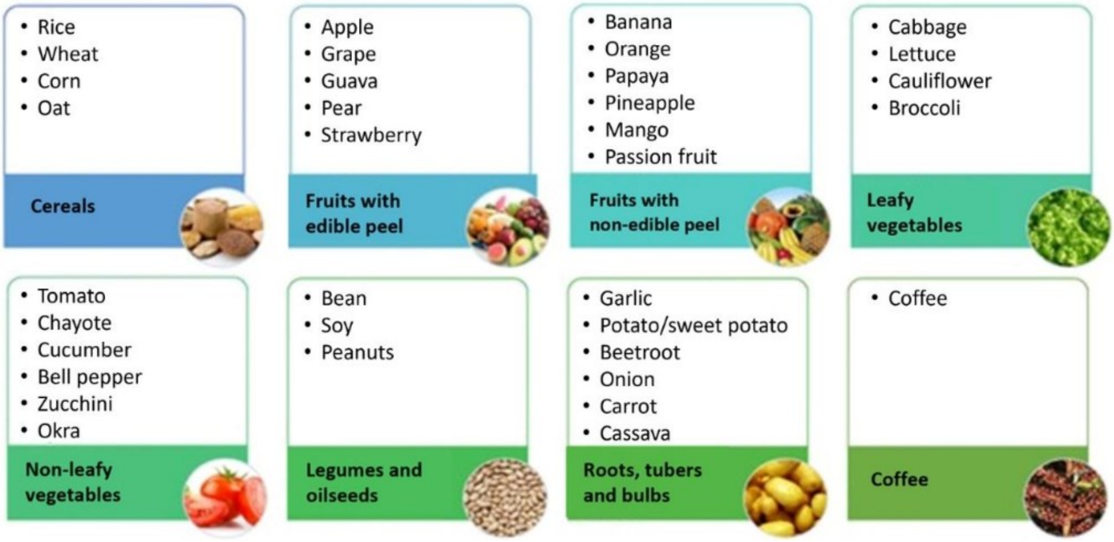
Due to these potential risks, monitoring and control strategies were established to reduce cases of exogenous poisoning by pesticides. In 2001, the Pesticide Residue in Food Analysis Program (PARA) was created, established by the National Health Surveillance Agency (ANVISA) Resolution of the Board of Directors (RDC) No. 119/2003[9] and regulated by ANVISA's Ordinance No. 1,081/2023[10]. The program is coordinated by the National Health Surveillance System in conjunction with state and municipal surveillance agencies, and collects food samples from commercial establishments throughout the country.

In that regard, PARA has expanded its analytical capacity. Initially, the Health Surveillance monitored around 100 pesticides; today, more than 300 are analyzed[11]. Laboratory analyses are carried out in accordance with the requirements of the ABNT NBR ISO/IEC 17025 standard, using internationally validated and recognized methodologies[12]. Since its implementation, more than 45,000 samples of 36 foods have been analyzed, representing 80% of plant consumption in Brazil[13].

The interest in the topic arose from the author's work in Environmental Health Surveillance (VISAM) at the Ceará State Health Department (SESA-CE), highlighting the importance of studies on the impacts of pesticides on public health. Supporting this need, upon assuming the role of technical support in the Quality Management System at the Superintendency of the Fortaleza Region and the State Sanitary Surveillance Coordination (COVIS), he observed the work carried out by technicians in the State Sanitary Surveillance's PARA regarding food collection, noticing that it was, and still is, understudied.

Therefore, this work is justified by its high relevance to public health, considering the potential impacts on the population resulting from the presence of pesticide residues in food. Within this framework, this paper's aim was to identify the pesticide residues present in foods commercialized in the state of Ceará, highlighting those with the greatest diversity of residue types, based on data provided by PARA for the period 2018 to 2023.

Figure 1 – Products collected by the Pesticide Residue Analysis Program in Food



Source: adapted from Brazil, 2023[13]

METHODS

This is a descriptive quantitative research, using numerical and measurable data, allowing the construction of tables and descriptive statistical analyses. The research was carried out at COVIS, covering municipalities in the state of Ceará participating in PARA: Fortaleza, Maracanaú and Juazeiro do Norte. According to the Brazilian Institute of Geography and Statistics[14], in 2022, Ceará had a population of 8,794,957 inhabitants, distributed in 184 municipalities, with a total area of 148,894.447 km².

The collection of the samples analyzed in this study took place between 2018 and 2023. In the years 2020 and 2021, the collections were temporarily suspended due to the need to deal with Covid-19. Microdata were provided by COVIS, exclusively for academic purposes, anonymized and taken under the responsibility of the Health Surveillance of SESA-CE. The use of the data occurred following the ethical aspects of research.

Data collection was carried out after the ANVISA’s annual planning, complied with all of the National Agencies’ criteria, following standard operating procedures, which guaranteed the integrity of the collection and guided the process. The collected foods originated from supply centers (CEASA)/distributors, distributors, packers/manufacturers, and CEASA/manufacturers. Data on the types of food collected, quantities, packaging methods, and documents that ensure traceability were provided by the establishments themselves. Samples were collected in supermarkets, regardless of the product's origin. It is important to mention that the selection criteria for the PARA samples are based on choosing the foods with the highest consumption and highest risk of pesticide contamination in the Brazilian diet, according to ANVISA's statistical analysis[15].

In the 2018/2019 cycle, samples were collected in 29 locations, including large supermarkets in the aforementioned municipalities. In 2022, samples were collected from 17 supermarkets, and in 2023, samples were collected from 37 establishments, including large supermarkets.

Data collection from COVIS reports took place between July and August 2025. The data were organized in spreadsheets (Microsoft Excel, Microsoft Corporation, Redmond, WA, USA) and the analyses were performed using Stata software version 13.1 (StataCorp, College Station, TX, USA). First, a description of the samples from each cycle was carried out, considering the foods collected, the presence or absence of pesticide residues, the result of the report (satisfactory or unsatisfactory) and the sample (regular or irregular). Then, a comparative description of the quantity of different types of residues identified in the foods collected in each cycle was carried out.

The following variables were considered: regular or irregular samples; satisfactory or unsatisfactory reports; main pesticide residues identified; foods with the highest frequency of unsatisfactory samples.

It is noteworthy that the samples were classified as regular when all pesticides detected were authorized for the crop and had concentrations equal to or lower than the reference values (RV) or maximum residue limit (MRL), complying with current legislation; and irregular when at least one of these requirements was not met.

The final reports were classified, according to legal and technical criteria, as satisfactory, when the residues were within the MRLs or were residues without acute risk to health, not representing an unacceptable risk to the consumer's health; and unsatisfactory when the sample was considered unfit for consumption, when there was at least one situation: residue above the MRL, presence of pesticide not authorized for that crop or acute risk to health[15].

RESULTS

In the 2018/2019 cycle, 252 samples of oats, bananas, onions, citrus fruits, pears, cucumbers, wheat, soybeans, apples, papayas, and grapes were analyzed, collected in Fortaleza, Maracanaú, and Juazeiro do Norte, with the detection of 59 different pesticide residues. 137 (54.4%) samples were classified as unsatisfactory and 115 (45.6%) as satisfactory, while 198 (78.5%) samples were regular and 54 (21.5%) were irregular. When analyzing the products, it is evident that the highest percentage of unsatisfactory samples was in oats (100%; n=9), followed by cucumbers (94.4%; n=17) and pears (87.7%; n=50). Regarding irregularity, oats had the highest rate (89.8%; n=8), followed by cucumber (50%; n=9) and pear (43.9%; n=23). Data is detailed in Table 1.

Due to the Covid-19 pandemic, in 2022 only 96 samples were analyzed, collected throughout September, October, November and December, in the same three municipalities as the 2018/2019 cycle, with the detection of 39 pesticide residues. 63 samples (65.6%) resulted in unsatisfactory reports, mostly cabbage (100%; n=4), bell pepper (97.5%; n=38) and passion fruit (87.5%; n=21); 33 (34.4%) samples had satisfactory reports, with 74 (77.1%) regular samples and 22 (22.9%) irregular, mostly passion fruit (41.7%; n=10), and cabbage (75%; n=3). Table 2 shows the results for the year 2022.

In 2023, 345 samples of 12 different products (pineapple, garlic, rice, beetroot, carrot, chayote, citrus, guava, mango, bell pepper, tomato and grape) were collected with the detection of 67 different pesticide residues. 121 (35.1%) reports were satisfactory and 224 (64.9%) were unsatisfactory. Chayote and beetroot presented the highest rates of unsatisfactory samples (100%). 114 (33.1%) of the samples were irregular, mostly grapes (92.6%; n=25), and 231 (66.9%) were regular. Results are detailed in Table 3.

In the cycles surveyed, 2018/2019, 2022, and 2023, respectively, 59, 39, and 67 different pesticide residues were detected. Table 4 details which products were collected in each cycle, as well as the number of different pesticides found in each product. Note that the number of pesticide residues found is not due to the sum of those found in the products in the same year, as more than one pesticide may be used in different crops.

Table 1 – Food samples collected by the Pesticide Residue in Food Analysis Program in the 2018/2019 cycle in the state of Ceará (n=252)

	Product, n (%)												
	Oat	Banana	Onion	Citrus	Apple	Papaya	Corn	Cucumber	Pear	Soy	Wheat	Grape	Total
Total number of samples	9 (100)	3 (100)	4 (100)	27 (100)	32 (100)	41 (100)	1 (100)	18 (100)	57 (100)	1 (100)	20 (100)	39 (100)	252 (100)
Report													
Satisfactory	0	3 (100)	4 (100)	27 (100)	22 (68.8)	20 (48.8)	1 (100)	1 (5.6)	6 (12.3)	1 (100)	16 (80)	14 (35.9)	115 (45.6)
Unsatisfactory	9 (100)	0	0	0	10 (31.2)	21 (51.2)	0	17 (94.4)	51 (87.7)	0	4 (20)	25 (64.1)	137 (54.4)
Sample													
Regular	1 (11.2)	3 (100)	4 (100)	27 (100)	30 (93.8)	37 (90.2)	1 (100)	9 (50)	32 (56.1)	1 (100)	17 (85)	34 (87.2)	198 (78.5)
Irregular	8 (89.8)	0	0	0	2 (6.2)	4 (9.8)	0	9 (50)	23 (43.9)	0	3 (15)	5 (12.8)	54 (21.5)
Pesticides detected	3	2	3	11	14	16	1	12	19	1	7	26	59

Source: compiled by the author (2026). The same pesticide can be detected in more than one crop.

Table 2 – Food samples collected by the Pesticide Residue in Food Analysis Program in the 2022 cycle in the state of Ceará (n=96)

	Product, n (%)							
	Potato	Citrus	Beans	Passion fruit	Bell pepper	Cabbage	Wheat	Total
Total number of samples	7 (100)	13 (100)	2 (100)	24 (100)	39 (100)	4 (100)	7 (100)	96 (100)
Report								
Satisfactory	7 (100)	13 (100)	2 (100)	3 (12.5)	1 (2.5)	0	7 (100)	33 (34.4)
Unsatisfactory	0	0	0	21 (87.5)	38 (97.5)	4 (100)	0	63 (65.6)
Sample								
Regular	7 (100)	13 (100)	2 (100)	14 (58.3)	30 (77)	1 (25)	7 (100)	74 (77.1)
Irregular	0	0	0	10 (41.7)	9 (23)	3 (75)	0	22 (22.9)
Pesticides detected	4	8	2	13	24	3	4	39

Source: compiled by the author (2026). The same pesticide can be detected in more than one crop.

Table 3 – Food samples collected by the Pesticide Residue in Food Analysis Program in the 2023 cycle in the state of Ceará (n=345)

	Products, n (%)												
	Pineapple	Garlic	Rice	Beetroot	Carrot	Chayote	Citrus	Guava	Mango	Bell pepper	Tomato	Grape	Total
Total number of samples	17 (100)	12 (100)	13 (100)	6 (100)	6 (100)	7 (100)	18 (100)	140 (100)	4 (100)	40 (100)	55 (100)	27 (100)	345 (100)
Report													
Satisfactory	17 (100)	5 (41.7)	12 (92.3)	0	4 (66.6)	0	15 (83.3)	3 (2.2)	4 (100)	22 (55)	23 (41.8)	16 (59.2)	121 (35.1)
Unsatisfactory	0	7 (58.3)	1 (7.7)	6 (100)	2 (33.4)	7 (100)	3 (16.7)	137 (97.8)	0	18 (45)	32 (58.2)	11 (40.8)	224 (64.9)
Sample													
Regular	17 (100)	10 (83)	12 (92.3)	2 (33.4)	4 (66.6)	2 (28.5)	17 (94.4)	77 (55)	4 (100)	35 (87.5)	49 (89.1)	2 (7.4)	231 (66.9)
Irregular	0	2 (17)	1 (7.7)	4 (66.6)	2 (33.4)	5 (71.5)	1 (5.6)	63 (45)	0	5 (12.5)	6 (10.9)	25 (92.6)	114 (33.1)
Pesticides detected	7	9	7	6	5	7	12	26	3	28	30	17	67

Source: compiled by the author (2026). The same pesticide can be detected in more than one crop

Table 4 – Number of pesticides per crop collected/year in Ceará

	Year			Pesticides detected (year)
Product	2018/2019	2022	2023	
Apple	14	-	-	Bifenthrin; CS2; carbendazim; chlorothalonil; dimethoate; fenitrothion; phosmet; indoxacarb; tenflubezuron; dithianone; etofenproxi; fenitrothion; pyraclostrobin; pyrimethanil (2018/2019).
Banana	2	-	-	Flutriafol; tebuconazole (2018/2019).
Bean	-	2	-	Carbendazim and glufosinate (2022).
Beetroot	-	-	6	Acephate, cypermethrin (all isomers), clothianidin, pyraclostrobin, procymidone and thiamethoxam (2023).

Bell pepper	-	23	28	Cypermethrins, chlorfuzaron, formetanate, imidacloprid, propargite, dithiocarbamates, acephate, carbendazim, tebuconazole, clofenapyr, lambda-cyhalothrin, bifenthrin and formetanate (2022) acetate, acetamiprid, azoxystrobin, bifenthrin, cadusafos, cypermethrins (all isomers), chlorantraniliprole, chlorfenapyr, chlorpyrifos, difenoconazole, dithiocarbamates, etofenprox, fenpyroximate, fenpropathrin, flupiradifurone, flutraifol, formetanate, imidacloprid, indoxacarb, lambda-cyhalothrin, lufenuron, pyraclostrobin, pirimiphos-methyl, pyriproxyfen, profenofos, propargite, tebuconazole, teflubenzuron and terbufos (2023).
Cabbage	-	3	-	Imidacloprid (regular), procymidone and epoxiconazole (2022) Acetamiprid, azoxystrobin, bifenthrin, dithiocarbamates, spirodiclofen, imazalil, imidacloprid, malathione, methidathione, pyraclostrobin, pyriproxyfen, tebuconazole (2023).
Carrot	-	-	5	Acephate, chlorpyrifos, fluxapyroxad, glyphosate and procymidone (2023).
Chayote	-	-	7	Ciazofamide, fluopicolide, imidacloprid, methomyl, pyraclostrobin, tebuconazole and triflumizole (2023).
Citrus	11	7	12	Azoxystrobin; Bifenthrin; carbendazim; carbon disulfide (CS2); dimethoate; formetanate; imazalil; imidacloprid; malathion; tebuconazole; trifloxystrobin (2018/2019). Bifenthrin, acetamiprid, malathion, tebuconazole, imazalil, carbendazim and azoxystrobin (2022).
Corn	1	-	-	Chlorfenapyr (2018/2019).
Cucumber	12	-	-	Acephate, cypermethrins, chlorfenapyr, chlorpyrifos, methomyl, boscalid, carbendazim, cypermethrin, cs2, difenoconazole, indoxacarb, lambda-cyhalothrin (2018/2019).
Garlic	-	-	9	Azoxystrobin, cyprodinil, fluxapyroxad, hexythiazoxy, imidacloprid, pyraclostrobin, procymidone, tebuconazole and thiamethoxam (2023).
Grape	26	-	17	Ethephon, fenpyroximate, hexithiazoxy, mandipropamide, propargite, azoxystrobin, bifenthrin, boscalid, cyazofamide, cyproconazole, difenoconazole, dimethomorph, fenamidone, imidacloprid, lambda-cyhalothrin, pyraclostrobin, pyridaben, tebuconazole, tetraconazole, trifloxystrobin, zoxamide, cyazofamide, chlorantraniliprole, cs2, dimetomorph and etofenproxi (2018/2019). acephate, acetamiprid, bifenthrin, cyazofamid, cypermethrin (all isomers), chlorantraniliprole, clothianidin, difenoconazole, dimethomorph, ethephon, etofenprox, flupiradifurone, metalaxyl-m, tebuconazole, tetraconazole, thiamethoxam and trifloxystrobin (2023).
Guava	-	-	25	Acetamiprid, azoxystrobin, bifenthrin, dithiocarbamates, spirodiclofen, imazalil, imidacloprid, malathion, methidathione, pyraclostrobin, pyriproxyfen and tebuconazole (2023).
Mango	-	-	3	Azoxystrobin (2), dithiocarbamates and imidacloprid (2023).
Oat	3	-	-	Cypermethrin; pirimiphos-methyl; deltamethrin (2018/2019).
Onion	2	-	-	Imidacloprid; carbendazim (2018/2019).

Papaya	14	-	-	Carbofuran, spiromesifene, acetamiprid, bifenthrin, carbendazim, chlorfenapyr, cs2, fenpyroximate, imidacloprid, tebuconazole, cypermethrin, chlorothalonil, difenoconazole and pyraclostrobin (2019/2019).
Passion Fruit	-	13	-	Cypermethrins, chlorfuzarom, formetanate, imidacloprid, propargite, dithiocarbamates, acephate, carbendazim, tebuconazole, clofenapyr, lambda-cyhalothrin, bifenthrin and formetanate (2022).
Pear	19	-	-	Bifenthrin, boscalid, buprofezin, carbendazim, chlorpyrifos, clothianidin, difenoconazole, imazalil, pyraclostrobin, pyriproxyfen, thiacloprid, thiamethoxam, acetamiprid, capitan, cs2, pyrimethanil, tebuconazole, thiabendazole and trifloxystrobin (2018/2019).
Pineapple	-	-	7	Cabendazim, cypermethrin (all isomers), ethephon, flutriafol, imidacloprid, tebuconazole, and triflocistrobin (2023).
Potato	-	4	-	Cyromazine, fluopyram, pencicuron and procymidone (2022)
Rice	-	-	7	Cyproconazole, chlorpyrifos, glyphosate, imidacloprid, pyrifos-methyl, quinclorak and tebuconazole (2023).
Soy	1	-	-	Isoxaflutol (2018/2019).
Tomato	-	-	29	Azoxystrobin, bifenthrin, boscalid, carbaryl, carbendazim, cyantraniliprole, cypermethrin (all isomers), cyromazine, chlorantraniliprole, chlorfenapyr, chlorothalonil, chlorpyrifos, clothianidin, cs2, deltamethrin, difenoconazole, famoxadone, fipronil, flubendiamide, indoxacarb, lambda-cyhalothrin, lufenuron, methoxyfenozide, pyraclotropin, pyraclostrobin, procymidone, profenophos, propamocarb, teflubenzuron and thiamethoxam (2023).
Wheat	7	4	-	Chlorpyrifos-methyl, dichlorvos, pirimiphos-methyl, chlorpyrifos, deltamethrin, lambda-cyhalothrin and malathion (2018/2019) chlorpyrifos, malathion, pirimiphos-methyl and glyphosate (2022).

Source: compiled by the author (2026). Caption: - (this food was not collected during the year).

DISCUSSION

This study investigated the presence of different pesticide residues in foods sold in the state of Ceará, using data extracted from reports produced by PARA between 2018 and 2023. In the three cycles, most of the analyzed foods presented unsatisfactory reports, that is, with residues above the maximum limit and/or not permitted for that specific crop, and had regular samples, when the residues found were permitted and were below the RV. Despite the absence of sample collections in the years 2020-2021 and the significant reduction in collections in 2022, resulting from the Covid-19 pandemic, there was a proportional increase in the diversity of residues detected in the 2022 and 2023 cycles, in addition to the persistence of irregularities, especially among fruits and vegetables.

Following the Covid-19 crisis, PARA collections only resumed in July 2022[16]. With a reduced staff due to time constraints, retirements, and leaves of absence, as well as limited laboratory resources, COVIS was unable to maintain the number of collections; however, the reduced collections did not translate into improved sample quality. The suspension of collections in the 2020-2021 biennium and the reduction in collections in 2022 raises the hypothesis of underdetection of acute poisonings from the consumption of contaminated products, reinforcing the importance of the continuity of PARA, even in health crisis scenarios.

The number of collections carried out in Ceará in the years prior to the pandemic continues to be higher than that currently carried out[16]. In the national scenario, a growing number of pesticides have been permitted every year[17], and the amount of collections carried out by PARA has remained reduced. This reduction becomes worrying when considering that, in 2023 in Ceará, with the expanded resumption of collections, the greatest diversity of residues (67 different types detected) was observed since the 2018/2019 cycle. The data thus suggest that the problem regarding the irregularity of samples in the state is not punctual, but rather structural, which reflects consolidated agricultural practices and difficulties in quality and safety control throughout the production chain.

Crops such as fruits and vegetables, which in this study presented a high number of residues in the three cycles studied, are usually more susceptible to pests, receiving successive and combined applications of pesticides[17]. In 2023, guava samples had 97.8% unsatisfactory reports, with 45% of samples being irregular and the presence of 25 different pesticide residues. Grape samples, a fruit with a national history of irregularities in PARA[18], had a high diversity of pesticide residues in the 2018/2019 and 2023 cycles. The same happened with vegetables such as bell peppers, which showed a high number of residues in 2022 and 2023, with the recurring presence of pesticides not authorized for the crop; and with cucumbers, which in the 2018/2019 cycle had 94.4% unsatisfactory reports.

The most frequently found pesticide residues in the 2018/2019 cycle were Carbendazim, CS2, and Bifenthrin (20, 20, and 15 detections, respectively); in the 2022 cycle, they were Imidacloprid, Malathion, and Tebuconazole (15, 6, and 6 detections, respectively); and, in the 2023 cycle, Imidacloprid, Tebuconazole, and Cypermethrin (29, 29, and 21 detections, respectively). Frequent detection of Imidacloprid, an insecticide widely used also in veterinary products, was observed, as well as Dithiocarbamates, such as Mancozeb, a fungicide used in crop protection. In addition to these, the presence of Glyphosate, the most widely used herbicide in the world, was noted, and it may be the cause of a higher frequency of diseases affecting the central nervous system[19].

Current legislation evaluates each active ingredient (AI) in isolation, but does not adequately consider the synergistic effects of combined consumption, also known as the “pesticide cocktail” phenomenon, which occurs when several pesticide residues are mixed in the same product[20]. Studies indicate that combined exposure can potentiate toxic effects, generate effects that have not yet been measured, and increase neurological and carcinogenic health risks for consumers[20]. In this regard, tomatoes stand out, with 29 AIs detected in 2023 alone, and bell peppers, with 23 and 28 AIs in 2022 and 2023, respectively.

In addition, according to ANVISA, in the results of PARA in 2024, cucumber, orange and cabbage, staple products of the Brazilian diet, showed the highest number of samples above the permitted limit of pesticide residues, as well as substances not permitted for the crop[15].

Unlike previous years, Glyphosate began to appear in Ceará and continues to be one of the most detected pesticides in Brazil, although it is banned in many countries that buy Brazilian crops. Globally, France, as of January 4, 2026, suspended the import of fruits marketed by South American countries that contain residues of pesticides banned in Europe: Mancozeb, Glufosinate, Thiophanate-methyl and Carbendazim. The fruits banned are avocado, mango, guava, citrus fruits in general, grapes and apples[21].

Two of the four pesticides banned for import, Carbendazim and Mancozeb, had residues found in some of the samples collected and analyzed by PARA. Carbendazim was banned in Brazilian territory in August 2022, by RDC 739/2022[22] due to serious risks to human health. The ban implies the discontinuation of production, import, marketing and use, until November 2024, however the stock can be used until the expiration date[22].

Thus, in addition to VISAM and Sanitary Surveillance, the Health Surveillance of Populations Exposed to Pesticides becomes a central point in the care regarding pesticide residues, especially in areas where there are plantations of crops most affected by these pesticides, considering that the population living near the plantation is susceptible to direct contact, and to the ingestion of such foods. It is also necessary to consider the pollution of the water table and the contamination that workers can bring to their families[23].

Regarding the quality of the food produced, according to Santos[24], it was recommended to the Sanitary Surveillance, aiming at the production of quality food free from contamination, to provide guidance for adapting kitchens based on sanitary legislation, good manufacturing practices courses with notions of hygiene, handling, packaging, labeling, preservation and transport. Monitoring of processed foods was also recommended, microbiological analyses that can discover contaminants in foods from the Food Acquisition Program of the Federal Government[24].

Brazil has been suffering from the increasing release of permitted pesticides, and the studies used to support this permission are not found. The 2024 cycle of PARA was published after the start of the production of this article. Of the 3,084 samples analyzed, 791 showed detection of residues and 1,657 had residues less than or equal to the VR or LMR, totaling 2,448 satisfactory reports[15]. It is necessary to monitor the crops most consumed by the Brazilian people, and beyond that, educational and surveillance work must be carried out, as the chemical products used may cause problems for human health in the not-too-distant future[25]. PARA is a strategic tool and should be better used for the inspection and control of pesticides used, just as the government should subsidize educational, regulatory and intersectoral actions in order to improve the diet of the Brazilian people.

CONCLUSION

This study's strengths lie in the use of official microdata from PARA provided by COVIS and an extensive temporal analysis, covering three distinct collection cycles (2018/2019, 2022, and 2023) in the state of Ceará. The use of this data lends the results significant sanitary relevance. The identification of foods with the most detected irregularities, in addition to the high diversity of pesticide residues, highlights the risk of the combined use of multiple active ingredients, emphasizing the direct applicability of the findings to strengthening Sanitary Surveillance actions and public health policies. It is important to note that the use of secondary data, with collections dependent on the national PARA calendar, is a limitation of this study. The reduction in the number of annual collections due to the Covid-19 pandemic limits the descriptive and statistical comparative analysis between cycles, and the absence of an individualized assessment of the risk derived from the ingestion of foods with pesticide residues can also be considered a limitation of the study. Still, there is no compromise to the relevance of the work, considering the detailed scenario of the presence of pesticide residues in products marketed in the state.

In conclusion, this work, structured from microdata from reports of PARA, ratified national and international data on the incorrect, large-scale, and excessive use of pesticides. Thus, the need to monitor the use of these substances is reinforced, considering the risks to the health of agricultural workers and the general population, as well as the risk of combining different types of residues in the same food.

It is expected that the results will contribute to public health management, promoting awareness and education about the risks associated with the use of pesticides and strengthening PARA; educational actions for producers and, above all, a review of public policies on the subject with an intersectoral approach.

REFERÊNCIAS

1. BRASIL. Instituto Nacional de Câncer (INCA). *Agrotóxicos e risco à saúde*. 2022.
2. FAO. *FAOSTAT – Pesticides Use*. Organização das Nações Unidas para Alimentação e Agricultura, 2021.
3. Brasil. Ministério da Saúde. Portaria nº 3.214, de 8 de junho de 1978. Normas Regulamentadoras de Segurança e Medicina do Trabalho. Diário Oficial da União, 1989; 8 jun.
4. Braibante MEF, Zappe JA. A química dos agrotóxicos. Química Nova Escola. 2012; 34(1): 10-15.
5. Chattopadhyay S, Chattopadhyay D. Remediation of DDT and Its Metabolites in Contaminated Sediment. Pollution Rep. 2015; 1: 248-264.
6. Brasil. Lei nº 11.936, de 14 de maio 2009. Proíbe a fabricação, a importação, a exportação, a manutenção em estoque, a comercialização e o uso de diclorodifeniltricloretano (DDT) e dá outras providências. Diário Oficial da União, 2009; 14 mai.
7. Brasil. Ministério do Meio Ambiente e Mudança do Clima. Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis (IBAMA). Relatório de comercialização de agrotóxicos. IBAMA. Brasília: 2024.
8. Prado IS, da Rocha AA, Silva LA, Gonzalez VC. Glyphosate-based formulation affects Tetragonisca angustula worker's locomotion, behavior and biology. Ecotoxicology. 2023. 32: 513-524.
9. Brasil. Ministério da Saúde. Agência Nacional de Vigilância Sanitária. Resolução da Diretoria Colegiada – RDC nº 119 de 19 de maio 2003. Institui o Programa Nacional de Resíduos de Agrotóxicos em Alimentos (PARA) e dá outras providências. Diário Oficial da União, 2003; 20 mai.
10. Brasil. Ministério da Saúde. Agência Nacional de Vigilância Sanitária (ANVISA). Portaria nº 1.081, de 27 de setembro de 2023. Regulamenta o Programa de Análises de Resíduos de Agrotóxicos em Alimentos (PARA). ANVISA. Brasília; 2023.
11. Brasil. Ministério da Saúde. Agência Nacional de Vigilância Sanitária (ANVISA). Anvisa dá início ao ciclo de monitoramento de resíduos de agrotóxicos em alimentos. ANVISA. Brasília; 2025. Disponível em: https://www.gov.br/anvisa/pt-br/assuntos/noticias-anvisa/2025/anvisa-da-inicio-ao-ciclo-de-monitoramento-de-residuos-de-agrotoxicos-em-alimentos.
12. Brasil. Associação Brasileira de Normas Técnicas. ABNT NBR ISO/IEC 17025: Requisitos gerais para a competência de laboratórios de ensaio e calibração. Rio de Janeiro; 2017. Disponível em: https://www.exactusmetrologia.com.br/sites/default/files/3-nbr_iso_iec_17025-2017_versao_exclusiva_treinamento.pdf.
13. Brasil. Ministério da Saúde. Agência Nacional de Vigilância Sanitária (ANVISA). Programa de Análise de Resíduos de Agrotóxicos em Alimentos - PARA. Plano Plurianual 2017-2022. Resultados dos Ciclos 2018-2019 e 2022. Brasília; 2023. Disponível em: https://www.gov.br/anvisa/pt-br/assuntos/agrotoxicos/programa-de-analise-de-residuos-em-alimentos/arquivos/apresentacao-para-2018-2022.pdf.
14. Instituto Brasileiro de Geografia e Estatística (IBGE). Censo Demográfico 2022: resultados gerais do Ceará. IBGE. Rio de Janeiro; 2022.
15. Brasil. Ministério da Saúde. Agência Nacional de Vigilância Sanitária (ANVISA). Programa de Análise de Resíduos de Agrotóxicos em Alimentos (PARA). Relatório dos resultados das análises de amostras monitoradas no ciclo 2024. Brasília; 2025. Disponível em: https://www.gov.br/anvisa/pt-br/assuntos/agrotoxicos/programa-de-analise-de-residuos-em-alimentos/arquivos/relatorio-para-2024.
16. Brasil. Ministério da Saúde. Agência Nacional de Vigilância Sanitária (ANVISA). Anvisa divulga resultados do monitoramento de resíduos de agrotóxicos em alimentos. Brasília; 2023. Disponível em: https://www.gov.br/anvisa/pt-

br/assuntos/noticias-anvisa/2023/anvisa-divulga-resultados-do-monitoramento-de-residuos-de-agrotoxicos-em-alimentos.
17. Hess SC, Nodari R. Agrotóxicos no Brasil: panorama dos produtos entre 2019 e 2022. Ambientes Mov. 2022; 2(2): 39-52
18. Brasil. Ministério da Saúde. Agência Nacional de Vigilância Sanitária (ANVISA). Programa de Análise de Resíduos de Agrotóxicos em Alimentos (PARA). Relatório das análises de amostras monitoradas período de 2013 a 2015. Brasília; 2016. Disponível em: https://www.gov.br/anvisa/pt-br/assuntos/agrotoxicos/programa-de-analise-de-residuos-em-alimentos/arquivos/relatorio-2013-2015.
19. Costas-Ferreira C, Durán R, Faro LRF. Toxic Effects of Glyphosate on the Nervous System: A Systematic Review. Int J Mol Sci. 2022; 23(9): 4605.
20. Roth N, Wilks MF. Combination (“cocktail”) effects of pesticide residues in food SCAHT report for FSVO. Zurich: SCHAT; 2018.
21. Salati P. França vai suspender importação de frutas do América do Sul com agrotóxicos proibidos na Europa. G1 [Internet]. 2026. Disponível em: https://g1.globo.com/economia/agronegocios/noticia/2026/01/05/franca-suspende-importacao-de-frutas-do-mercosul-com-agrotoxicos-proibidos-na-europa.ghtml.
22. Brasil. Ministério da Saúde. Agência Nacional de Vigilância Sanitária. Resolução da Diretoria Colegiada – RDC nº 739 de 8 de agosto 2022. Dispõe sobre a proibição do ingrediente ativo Carbendazim em produtos agrotóxicos no país e sobre as medidas transitórias de mitigação de riscos. Diário Oficial da União, 2022; 8 ago.
23. Ceará. Boletim Epidemiológico n° 01/2023, de 24 de janeiro de 2023. Programa Nacional de Vigilância de Populações Expostas a Contaminantes Químicos (VIGIPEQ/VSPEA). Disponível em: https://www.saude.ce.gov.br/wp-content/uploads/sites/9/2018/06/VIGIPEQ_boletim_epidemiologico_20230124.pdf.
24. Santos JHN, Alencar OM, Costa TES, Pereira TM, Alves AF. Segurança Sanitária dos alimentos Fornecidos pela agricultura familiar em Itapajé, Ceará: desafios para vigilância sanitária. Cad. ESP/CE. 2017; 158-178.
25. Carneiro FF. organizador. Dossiê ABRASCO: um alerta sobre os impactos dos agrotóxicos na saúde. Rio de Janeiro: EPSJV; 2015.

Autor Correspondente

Pedro Iori Vale de Carvalho
pedrocarvalho1607@gmail.com

Author Contributions

Formal analysis: PIVC; **Conceptualization:** PIVC, RSB; **Data curation:** BLO; **Writing – review and editing:** PIVC, SEPF, TESC, and RSB; **Writing – original draft:** PIVC; **Supervision:** RSB.

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