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Program for the analysis of pesticide residues in food in the state of Minas Gerais: factors involved in traceability and sanitary control

Programa de análise de resíduos de agrotóxicos em alimentos do estado de Minas Gerais: fatores envolvidos na rastreabilidade e no controle sanitário

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ABSTRACT

Introduction: The monitoring of pesticide residues in food can contribute to control actions, mitigation of risks to human health and compliance with quality criteria related to national and international trade. **Objective:** To investigate and analyze the factors involved in the traceability and sanitary control of vegetable foods collected in the retail trade by the Program for the Analysis of Pesticide Residues in Food in the state of Minas Gerais (PARA- MG). **Method:** Based on a non-probabilistic sampling, the sanitary inspectors who worked in sample collection (n = 6) and those responsible for food quality control in the retail chains participating in the program (n = 12) were interviewed, using as a reference the *survey* method. **Results:** The results showed that 83.3% of sample collection sites are large establishments located in the metropolitan region of the state capital, which demonstrates that food sold in small retail establishments and open markets was not monitored by the program. According to the interviewees, 88.9% of the retail chains do not include traceability information on foods and 62.2% of the commercialized foods do not carry all the mandatory traceability information. **Conclusions:** The study identified factors related to companies, suppliers, rural producers and agencies that hinder the implementation of traceability in commercialized foods. Additionally, factors associated with operational issues, sampling of food products and related to the performance of control agencies that negatively affect the sanitary control of pesticide residues in food were identified. The study also proposes actions and measures aimed at promoting more transparency and safety in the food production chain.

KEYWORDS: Health Surveillance; Information; Food Safety; Pesticides; Consumer

RESUMO

Introdução: O monitoramento de resíduos de agrotóxicos em alimentos pode contribuir para ações de controle, mitigação de riscos à saúde humana e cumprimento de critérios de qualidade relacionados ao comércio nacional e internacional. **Objetivo:** Investigar e analisar os fatores envolvidos na rastreabilidade e no controle sanitário de alimentos vegetais coletados no comércio varejista pelo Programa de Análise de Resíduos de Agrotóxicos em Alimentos do estado de Minas Gerais (PARA-MG). **Método:** A partir de uma amostragem não probabilística, foram entrevistados os fiscais sanitários que atuaram nas coletas de amostras (n = 6) e os responsáveis pelo controle de qualidade dos alimentos nas redes varejistas participantes do programa (n = 12), utilizando como referência o método *survey*. **Resultados:** Os resultados evidenciaram que 83,3% dos locais de coleta de amostras são estabelecimentos de grande porte localizados na região metropolitana da capital do estado, o que demonstra que os alimentos comercializados em pequenos estabelecimentos varejistas e feiras livres não foram monitorados pelo programa. De acordo com os entrevistados, 88,9% das redes varejistas não inserem informações de

rastreabilidade nos alimentos e 62,2% dos alimentos comercializados não trazem todas as informações obrigatórias de rastreabilidade. **Conclusões:** O estudo identificou fatores relacionados às empresas, aos fornecedores, aos produtores rurais e aos órgãos fiscalizadores que dificultam a implementação da rastreabilidade nos alimentos e fatores associados a questões operacionais, de amostragem dos produtos alimentícios e relativos à atuação dos órgãos de controle sanitário que interferem negativamente no controle sanitário de resíduos de agrotóxicos, ao mesmo tempo em que propõe ações e medidas voltadas para promover mais transparência e segurança na cadeia produtiva de alimentos.

PALAVRAS-CHAVE: Vigilância Sanitária; Informação; Segurança Alimentar; Agrotóxicos; Consumidor

INTRODUCTION

The recent discussion on the re-evaluation and flexibilization of the pesticide registration process in Brazil, driven by rural sectors and the chemical industry[1], resulted in the publication of a new regulatory framework in the country, containing new criteria for toxicological evaluation and classification regarding the registration and authorization of pesticide use[2,3]. According to data available on the Phytosanitary Pesticides System (AGROFIT), between 2016 and 2020, the country authorized the use of 2,012 active ingredients of pesticides, including new ones and derivatives, an increase of 146.9% over the previous five years[4].

Under Brazilian law, the authorization and registration of pesticides depends on compliance with the guidelines and requirements of the environmental (Brazilian Institute of Environment and Renewable Natural Resources - Ibama), health (Brazilian National Health Surveillance Agency - Anvisa), and agriculture (Ministry of Agriculture, Livestock and Food Supply - Mapa) agencies[5]. In addition, the decision to maintain the authorization or registration of these active ingredients depends on the outcome of actions to control and monitor pesticide and related residues in the food production chain of plant origin, competencies which are delegated to Anvisa and Mapa[6].

Currently, the monitoring of pesticide residues in food of plant origin in the country is carried out by two state programs: the National Plan for Control of Residues and Contaminants (PNCRC) and the Program for the Analysis of Pesticide Residues in Food (PARA). The PNCRC, set up by Mapa in 2008, analyzes the presence of pesticide residues and other chemical and biological contaminants in food collected from farms, processing establishments and supply centers, destined for the domestic market and export[7]. While PARA, created in 2003 by Anvisa, continuously assesses the levels of pesticide residues in plant foods sold within the country, but only on the retail market[8].

PARA is carried out by the National Health Surveillance System (SNVS), while Anvisa acts as the national coordinator of the program, the Health Surveillance bodies of the states and municipalities carry out the actions of collecting and monitoring the analyzed foods, within the scope of their territories. The main objective of the program is to assess the quality and safety of food and provide input for toxicological studies, both for registering an active substance and for mitigating the risks associated with the population's dietary exposure to pesticide residues[8]. In Minas Gerais, PARA collections were incorporated into PARA Minas Gerais (PARA-MG), which became part of the Minas Gerais Program for Monitoring the Quality of Products and Services Subject to Sanitary Control (PMQPS).[9]

Permanent monitoring of pesticide residues in food can drive the implementation of more effective control actions aimed at adopting good agricultural practices, mitigating risks to human health, and complying with the quality criteria expected for national and international trade[10]. In this way, the results of analyses of pesticides in food provide information for decision-making, especially on which pesticides and food products should be the target of further investigations, guiding the education, control and inspection actions of the Health Surveillance agencies.[11]

In Minas Gerais, the analysis of pesticide residues in food samples of plant origin collected by PARA between 2013 and 2017 showed that 62.3% of the food samples collected had some contamination by pesticide residues and that 22.6% of these were irregular under health legislation, both because of the presence of pesticide residues not authorized for the crop (21.6%) and because they contained active ingredients above the maximum permitted limits (3.0%). In addition, 5.8% of the samples contained residues of pesticides banned for use in the country[12]. Thus, assessing the traceability conditions and control measures carried out in the production chain regarding the presence of pesticide residues in food is important for guaranteeing food quality and safety.

Studies show that consumers are increasingly concerned about the quality and safety of food[13,14,15]. Other studies show that consumer demand for more transparency and safety in the food production chain and the establishment of international regulatory traceability mechanisms for food commodities have driven the development of increasingly modern and affordable traceability technologies.[16]

The Joint Normative Instruction (INC) of Anvisa/Mapa SDA No. 02, of February 7, 2018[17], provided for in Brazilian health legislation, defines traceability as a "set of procedures that makes it possible to detect the origin and monitor the movement of a product along the production chain, by means of recorded informational and documentary elements". The legislation made traceability compulsory from production to marketing of fresh plant products and defined the scope of information required and the deadlines for implementation for the different food groups: fruit; roots, tubers, and bulbs;

leafy vegetables and fresh aromatic herbs; and non-leafy vegetables. These deadlines were later extended with the publication of INC Anvisa/Mapa No. 1, of April 15, 2019[18].

In view of the above, this research aimed to investigate and analyze the factors involved in the traceability and sanitary control of fresh plant foods collected in the retail trade by PARA-MG.

METHOD

To carry out the research, interviews were conducted with health inspectors and those responsible for food quality control in retail chains located in municipalities participating in PARA-MG. For data collection, the survey research method was used as a reference, in which a quantitative approach is used with the aim of verifying the perception of the facts of a given population[19].

Initially, semi-structured questionnaires were drawn up to assess the factors involved in the traceability and sanitary control of fresh plant foods, which were organized into four sections: (1) participant data; (2) knowledge about pesticides and PARA; (3) knowledge about traceability; (4) evaluation of the effectiveness of PARA-MG.

The study sample was selected in a non-probabilistic way and considered all the municipalities (n = 6) that participate in PARA-MG and the food retail chains (n = 17) that had samples collected by the program between 2013 and 2017. The sample consisted of individuals over the age of 18 who worked as Health Surveillance inspectors and were responsible for collecting food in the participating municipalities and individuals responsible for controlling the quality of plant foods in the retail chains where the samples were collected. The locations where the questionnaires were administered were known from the data in the PARA-MG analysis reports, made available by the Health Surveillance Superintendence of the MG State Health Department.

The professionals were invited to take part in the research and informed about the risks and benefits involved in the study by reading and signing the Informed Consent Form (ICF). All the procedures for carrying out the research were previously approved by the Research Ethics Committee (CEP) of the Federal University of Minas Gerais (UFMG) under opinion No. 3.508.440.

The survey took place between April and November 2020. Due to the high transmissibility of the new coronavirus (SARS-CoV-2) during the COVID-19 pandemic, data collection with health inspectors took place by sending the ICF and the questionnaire online to the participants' email addresses, obtained from the state coordination of the program. However, the questionnaires were administered to those responsible for quality control at retail chains at a time when the virus was less transmissible in the state of Minas Gerais and were therefore carried out on *site* by the researcher.

In order to assess the traceability of food, regardless of how it was sold (packaged or in bulk), every batch of food exposed for consumption was considered to be regular if it contained mandatory information from the immediately preceding entity in the production chain, as provided for in the legislation[17].

The data obtained from the answers to the closed questions was coded, tabulated, and arranged in spreadsheets. The answers to the open questions were systematized, classified, and distributed into thematic axes in order to quantify and describe their content. The data was analyzed descriptively and the results were presented in graphs and tables containing data expressed in frequencies and percentages.

RESULTS AND DISCUSSION

Profile of survey participants

Eighteen participants were interviewed, six of whom worked as health inspectors in the municipalities that took part in PARA-MG and 12 of whom were responsible for the quality control of plant foods in retail chains. These chains represented 85.7% of the locations selected for food collection in the program, given that some of them were excluded from the survey either because they had been incorporated into other chains that never had samples collected (three chains) or because they refused to participate (two chains).

When analyzing the collection sites, it was observed that only four supermarkets belonging to four different food retail chains, located in the same city, accounted for 81.1% of the collection sites. It can therefore be said that there is little alternation between collection points during the program's implementation in the state.

The individuals responsible for the quality control of plant foods in the participating retail chains worked in 31 supermarkets (86.1%) and five fruit and vegetable stores (13.9%). These professionals worked in more than one establishment and had different job titles, such as quality manager (66.7%), quality analyst (16.7%), fruit and vegetable supervisor (8.3%), and health inspection manager (8.3%). For the purposes of this study, they were only referred to as quality managers.

Regarding the population size of the six municipalities participating in PARA-MG, two had a population of up to 300,000 inhabitants, three had between 300,000 and 700,000 inhabitants and one had over 700,000 inhabitants[20]. All were located in the metropolitan region of the state capital. The most populous municipality was home to 66.7% of the establishments where PARA-MG collections were carried out, which shows that the collections hardly represent the food sold in small municipalities. However, these smaller municipalities only joined the program in 2017.

The survey also showed that 83.3% of the establishments in which collections were made were large, which shows that the food sold in small retail establishments and street markets, which include many family farmers, was not monitored by the program during the period analyzed.

Table 1 shows the profile of the interviewees. Most of them were adult men over the age of 25. When comparing the length of professional experience between the two groups, most of the quality managers had less than 10 years' experience, while most of the health inspectors had more than 10 years' experience. When looking at education level, the majority of health inspectors had a higher level of education than the quality managers.

Knowledge about pesticides and the effectiveness of PARA-MG

According to Figure 1, most of the managers and inspectors interviewed reported good or fair knowledge of pesticides in food. However, most of them were unable to answer about their ability to understand what is written in the PARA analysis reports. For better clarification, the adjective good can be understood as desirable and regular as satisfactory.

The majority of quality managers considered PARA's effectiveness in controlling pesticide residues in food to be good. On the other hand, half of the inspectors rated this effectiveness as fair. Furthermore, most of the managers and half of the inspectors did not know how to assess the actions of the Health Surveillance Agency, which shows that there does not seem to be an understanding of the real role of the health control body in relation to the risks posed by the presence of pesticide residues in food (Figure 1).

Figure 2 shows that the majority of interviewees, both quality managers and inspection agents, reported that they had not received analysis reports from PARA-MG. This could compromise risk management and communication in cases where food is contaminated with prohibited or irregular substances. The information in the reports could, in cases like these, result in the application of possible appropriate control measures and the exchange of information between those responsible, as provided for in the basic guidelines for risk assessment and food safety[21].

Regarding the measures taken, only half of the quality managers reported that health surveillance actions had been taken to deal with the irregular presence of pesticide residues in food in their establishments, while the rest did not report any actions taken by the Health Surveillance or were unable to answer (Figure 2). Although the legislation provides for the withdrawal and destruction of food containing irregular pesticide residues from the market[6], the lack of knowledge of the results of the reports by the municipal Health Surveillance and the length of time between the date of collection and the issue of the reports make this action impossible. In addition, the study found that the program's collections are not of a fiscal nature[9], which can make it difficult to be held accountable if irregularities are found.

When asked about the actions of the Health Surveillance Agency, most of the managers said that there had been no actions on the part of the inspection body (41.7%), while the others said that the Health Surveillance Agency had only provided guidance on the program (33.3%) and notified them of the results of analysis reports (16.7%). When this question was put to the health inspectors, half couldn't answer and the other half said that they carried out educational activities (33.3%) and notified the results of analysis reports (16.7%).

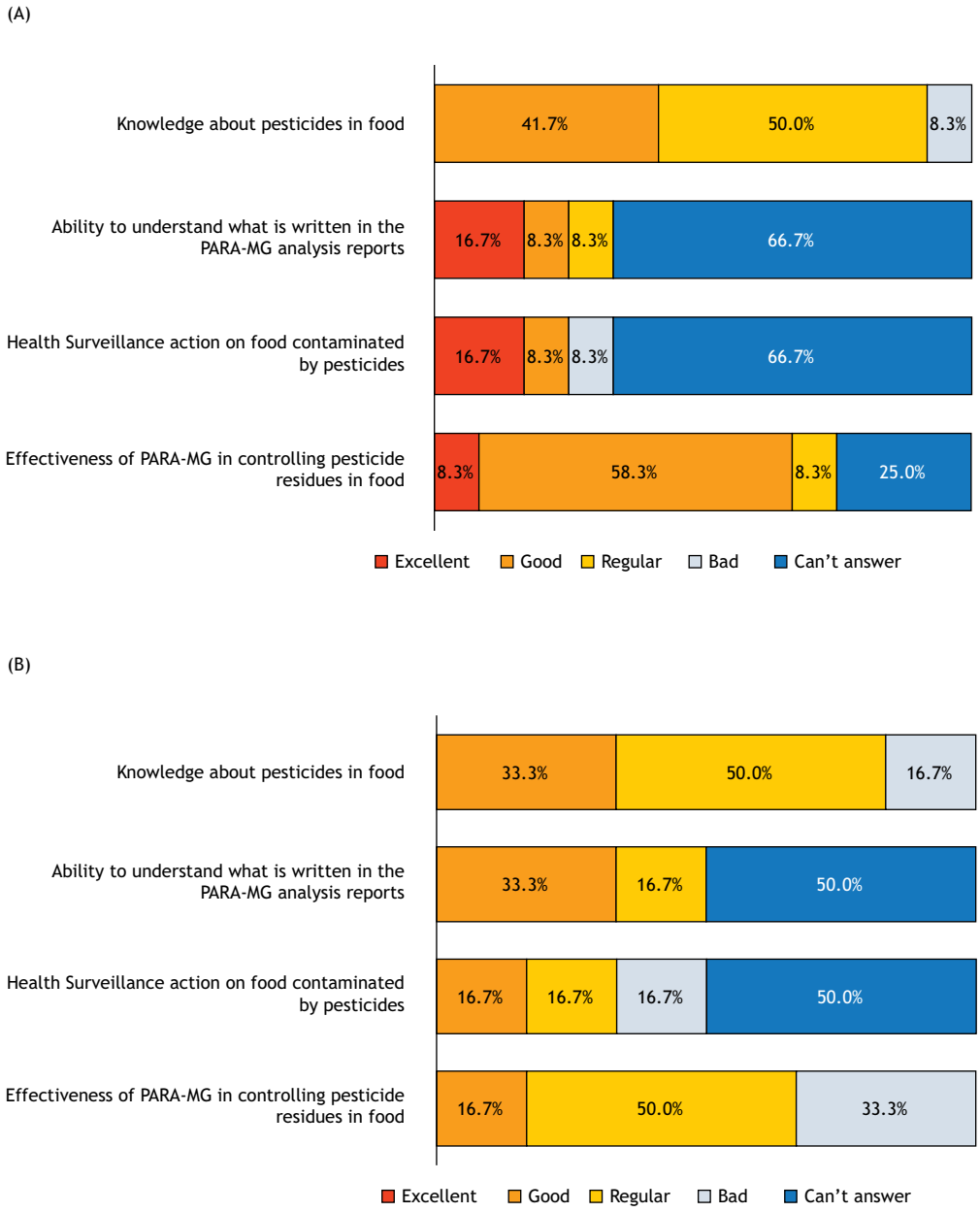
When the quality managers were asked about the actions taken in their establishments to deal with the presence of pesticides, half of them replied that they did not take any action and the other half only communicated the results of the analysis to their suppliers (Figure 2). However, health legislation defines that it is the responsibility of the establishment to control and supervise the risk of food contamination, comply with the requirements of good manufacturing practices, and intervene whenever necessary, with a view to ensuring food that is fit for human consumption[22].

All the inspectors interviewed reported that the sale of food with pesticide residues, even when not in compliance with the legislation, does not result in punishment for any entity in the production chain (Figure 2). However, state legislation stipulates that the regularization of enterprises presupposes compliance with health safety requirements, under penalty of liability[23,24].

When asked about the responsibility for the presence of food contaminated by pesticide residues on sale, 58.3% of the quality managers said that it was the responsibility of everyone involved in the production chain, 25.0% of the rural producers and 16.7% of the inspection bodies. On the other hand, 50.0% of health inspectors believe that this responsibility falls to the rural producer, 33.3% to the inspection bodies and 16.7% to everyone

Table 1. Profile of quality managers (n = 12) and health inspectors interviewed (n = 6).

Variables studied	Quality managers n (%)	Health inspectors n (%)
Gender		
Female	2 (16.7)	2 (33.3)
Male	10 (83.3)	4 (66.6)
Age group		
25 < 34	5 (41.7)	1 (16.7)
35 < 44	2 (16.7)	3 (50.0)
45 < 54	4 (33.3)	2 (33.3)
55 < 64	1 (8.3)	-
Professional performance time		
2 < 5 years	2 (16.7)	-
6 < 10 years	6 (50.0)	1 (16.7)
11 < 20 years	4 (33.3)	2 (33.3)
> 20 years	-	3 (50.0)
Education		
Complete high school	8 (66.7)	1 (16.7)
Complete higher education	3 (25.0)	2 (33.3)
Complete postgraduate degree	1 (8.3)	3 (50.0)



Source: Prepared by the authors, 2022.
PARA-MG: Program for the Analysis of Pesticide Residues in Food in the state of Minas Gerais.

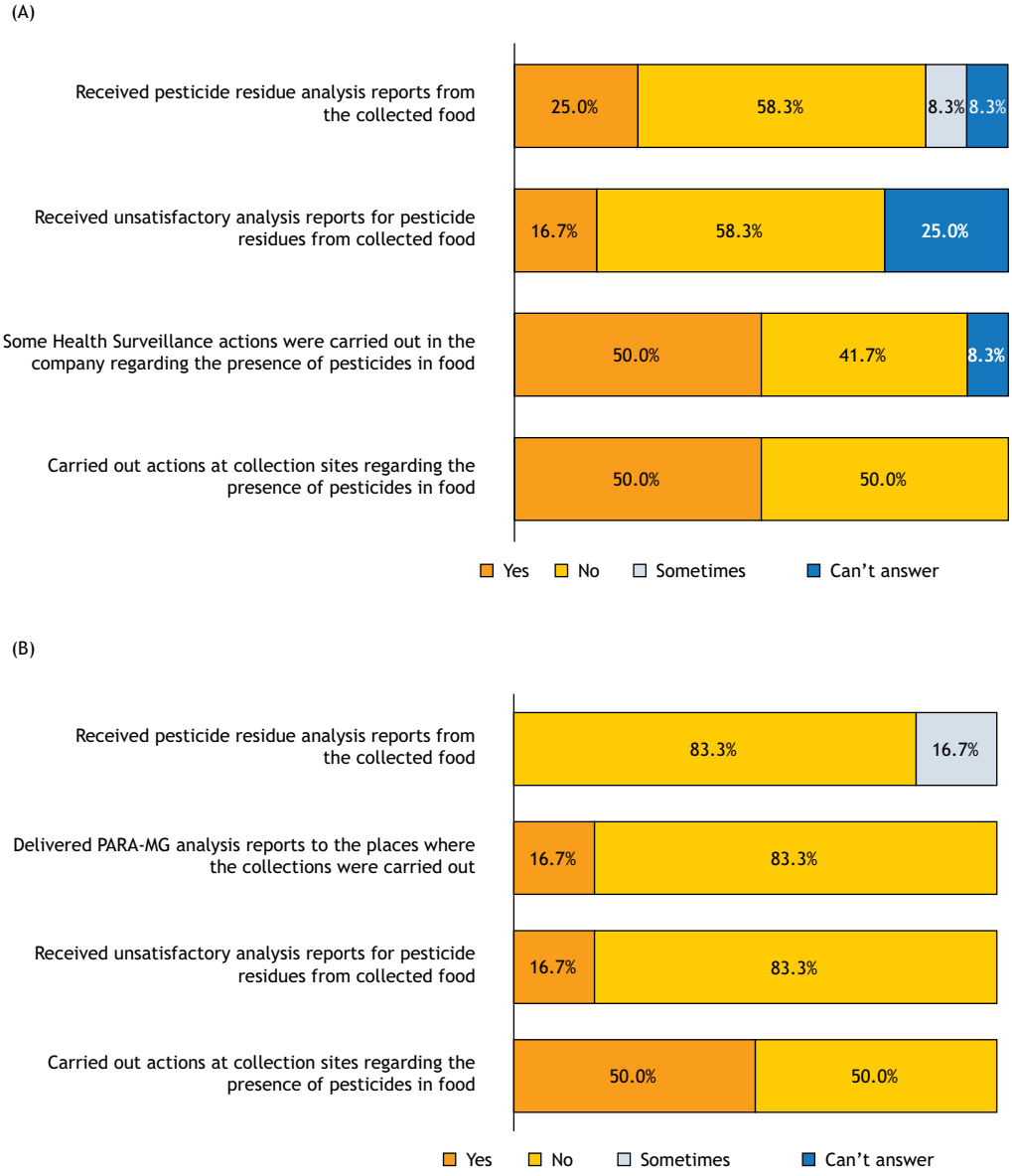
Figure 1. Percentage of responses from quality managers (A) and health inspectors (B) regarding knowledge about pesticides and PARA.

involved in the production chain. Therefore, while the majority of managers believe that everyone in the production chain is responsible for the presence of pesticide residues in food, the majority of inspectors believe that the responsibility lies mainly with the rural producer.

Not only the presence of pesticides but also other hazards in food products has been a growing concern for modern consumers, which has resulted in an increasing demand for information about the path the product takes from "farm to fork"[13,14,15]. As a result, traceability has been treated as a quality attribute, capable of offering greater transparency and security to the supply chain[25].

Traceability and pesticide residues in food

According to Brazilian legislation, traceability must be ensured by each entity in the fresh plant food production chain at all stages under its responsibility, in order to guarantee the identification of the immediately preceding and following entity in the production chain and the fresh plant products received and shipped[17,18]. In MG, establishments involved in the transportation



Source: Prepared by the authors, 2022.
PARA-MG: Program for the Analysis of Pesticide Residues in Food in the state of Minas Gerais.

Figure 2. Percentage of responses from quality managers (A) and health inspectors (B) in relation to their professional performance in the face of food contamination by pesticides.

of food must also keep, at the very least, records that make it possible to identify the immediately preceding and following companies in the production chain and the products received and delivered[26].

From the responses of the quality managers, it was possible to see that 88.9% of retail chains do not include traceability information on the packaging or labels of plant foods as soon as they receive them. This result shows that the identification of the subsequent entity is most often compromised for the majority of products.

The managers also revealed that 62.2% of the plant-based foods sold in the places where they work do not carry all the mandatory traceability information. Among the reasons for the absence of this information, a large proportion of those interviewed reported that labels and tags are commonly discarded along with the food packaging or bags, which means that the information from the previous link in the chain is inappropriately lost along with the packaging.

When managers were asked about the traceability of each type of agricultural crop, it was found that the fruit group

(29.5%) and the group of leafy vegetables and aromatic herbs (32.3%) had the lowest percentage of traceable foods, to the detriment of the group of non-leafy vegetables (48.3%) and the group of roots, tubers, and bulbs (43.0%). It is worth noting that, in a recently published study, non-leafy vegetables and fruit were the categories with the highest number of unsatisfactory reports for pesticide residues, both because they contained active ingredients not authorized for the crop and because they were above the maximum residue limits[12].

According to the quality managers, the main foods that were traceable up to the date of this survey were: grapes (91.7%), lettuce (66.7%), tomatoes (66.7%), broccoli (58.3%), cauliflower (58.3%), peppers (58.3%), and garlic (58.3%). The traceability of the other foods was less than 50.0% of the products on sale. It should be noted that the deadline set in the standard for the full implementation of traceability for all fresh plant products was August 1, 2021[18].

Studies have shown that the adoption of traceability systems by those involved in the food production chain is mainly associated with legal requirements and logistical aspects[16]. Although these systems are still seen as complex and costly, over time they have come to add value not only to the efficiency of logistics processes but also to health safety and the characteristics of the consumer market.

European Union (EU) legislation, for example, establishes that whenever there are reasonable grounds to suspect that a food may pose a risk to human or animal health, due to non-compliance with national and international standards, that public authorities, identifying as far as possible the products and the risks they may present, must inform the public as soon as possible[27]. When a certain risk is identified, EU countries and the Commission can adopt various measures, such as actions to restrict the movement of food or its withdrawal from the market; actions to prevent, limit or impose specific conditions on the placing on the market or possible use of food or feed and the rejection of imported food batches[28].

When asked about the origin of the food they sell, 83.3% of the quality managers said they buy their food from suppliers and the other 16.7% said they buy directly from producers. According to the managers, most of the food purchased is negotiated at a central supply center, where the food from different producers becomes part of a batch (consolidated batch). For 91.7% of them, the distance between the producer and the retail chain is one of the reasons that makes it difficult to know the origin of the food.

With a focus on food quality and safety, some countries have developed public policies to encourage food purchases based on a direct relationship between retailers and local producers. In China, for example, the government created the Farm Direct program in 2008, which supports the relationship between retailers, their suppliers and farming communities. The program promotes greater standardization and traceability of products, as well as encouraging good production practices and increasing safety in the fresh vegetable production chain[29].

Buying fresh fruit and vegetables produced in small production units is becoming increasingly common, as people generally place more trust in locally produced food than in products from long supply chains[30]. In addition, a food traceability system is a tool that can be used to meet consumer expectations regarding the quality and safety of food[31,32].

Most of the managers interviewed (75.0%) were unable to say how long traceability information is available to the health authorities. According to them, traceability information on fresh plant foods is kept for less time than other foods, due to the perishability of these products. According to the legislation, this period is at least 18 months after the products expire or are shipped[17] .

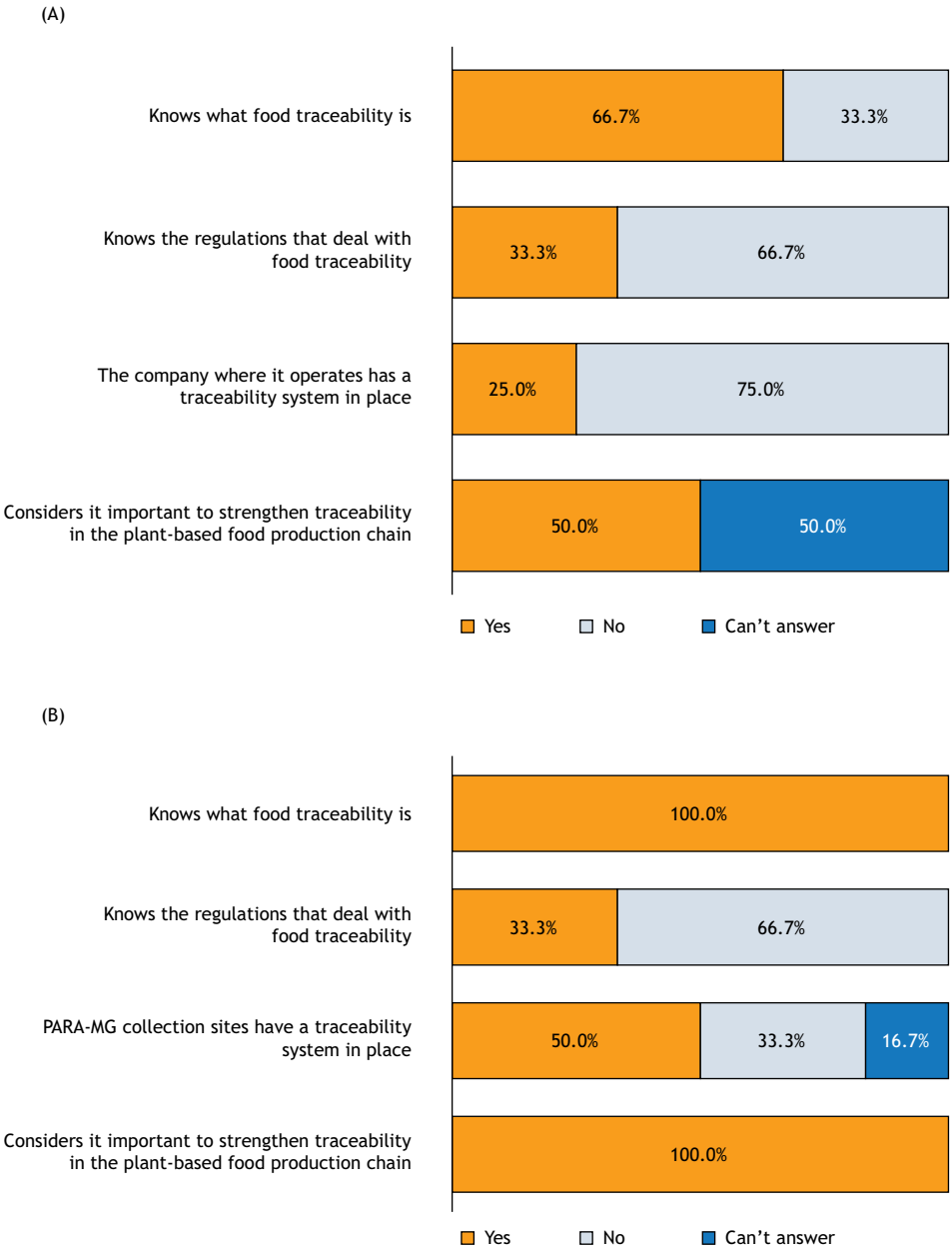
As can be seen in Figure 3, most of the quality managers and health inspectors interviewed are aware of what food traceability is. However, most of them are unaware of the regulations on traceability in the production chain.

Most of the managers and inspectors interviewed said they were unaware of the regulations dealing with food traceability. Furthermore, the lack of a traceability system in the establishments where PARA-MG samples are collected was reported by half of the inspectors and most of the managers interviewed. Despite this, all the inspectors and half the managers consider it important to strengthen traceability in the food production chain in order to control pesticide residues (Figure 3).

Only one of the quality managers reported that the retail chain where he works had traceability for all food (8.3%). According to the interviewee, traceability is required of suppliers when purchasing products, which are almost always delivered by suppliers with a two-dimensional code (QR code) printed on the packaging. For this manager, even if the QR code is there, complete information on the origin of the products is not always provided.

Based on the quality managers' answers about the factors that hinder the implementation of traceability, four thematic axes were created: (1) factors related to retail companies, (2) factors related to suppliers, (3) factors related to rural producers, and (4) factors related to inspection bodies. This question was answered by 75.0% of the managers, the rest either didn't answer or couldn't answer.

As for the factors related to retail companies, the managers cited the lack of interest on the part of business owners (25.0%), the fact that many establishments do not require traceability from their suppliers (16.7%), the lack of registration when products are received (8.3%), the difficulty of keeping traceability labels up to date (8.3%), the lack of an information system (8.3%), and the lack of knowledge of traceability standards (8.3%).



Source: Prepared by the authors, 2022.
PARA-MG: Program for the Analysis of Pesticide Residues in Food in the state of Minas Gerais.

Figure 3. Percentage of responses from quality managers (A) and health inspectors (B) regarding traceability.

Regarding food suppliers, the managers responded that the factors that hinder them are the unavailability of complete information on the origin of the products (41.7%) and the delivery of batches consolidated into a single batch (33.3%). According to the legislation, even when a consolidated batch is formed, consolidation units and establishments that process or handle fresh plant products must keep records of the mandatory information[17].

Regarding the factors relating to the rural producer, managers reported the absence of data and information from the primary producer on the boxes and packaging of the products (50.0%) and the difficulty in convincing small producers of the importance of implementing traceability for the credibility of their own business (25.0%). It is also important to consider that when the product leaves the farm, even if the chemical application notes (spray records), the name of the fruit and vegetable genus and the producer's details are provided, the chance of this information reaching the customer is low, as it is lost when it passes through the suppliers[32].

Regarding the factors involving the inspection bodies, the managers listed the failure to require traceability in all commercial establishments (41.7%) and the existence of shortcomings in the inspection of farmers regarding the use of pesticides (33.3%).

A study carried out in MG on the monitoring of PARA-MG showed the irregular presence of pesticide residues in the food collected by PARA-MG and the persistence of unsatisfactory results in the samples throughout 2013 and 2017. For these authors, the results showed shortcomings in good agricultural practices and the need for effective actions to control and mitigate the risks of food contamination by pesticides[12].

In Minas Gerais, the responsibility for inspecting farms and certifying that production complies with good agricultural practices has been delegated to the Minas Gerais Agricultural Institute (IMA). This certification is carried out by the Certifica Minas Program, in which the agency issues a seal of conformity that informs consumers that pesticides have not been used in the production of the food[33]. However, when asked about the marketing of food containing the seal of this program, none of the interviewees in this survey reported knowing about the program or the existence of food certified with the seal issued by the IMA, which indicates weaknesses in the execution of the respective program in the state.

Weaknesses in the sanitary control of pesticide residues in food

The interviewees also answered questions about the weaknesses that compromise the effectiveness of sanitary control of pesticide residues. These weaknesses were classified under the following headings: (1) factors related to operational issues, (2) factors related to sampling, and (3) factors related to the actions of health control bodies. 58.3% of quality managers and 83.3% of health inspectors answered this question. The rest didn't answer or couldn't answer.

Regarding operational factors, the quality managers reported not receiving the reports with the analysis results (25.0%), the lack of dissemination of the program's results to the population (8.3%), and the insufficient number of professionals in Health Surveillance to carry out the actions (8.3%). On the other hand, the health inspectors pointed out the non-receipt or late receipt of reports with analysis results (33.3%), the lack of training in sample collection (16.7), the deterioration of samples considering the time between collection and entry into the laboratory (16.7%), and the difficulty in feeding the information system that manages the program's samples (16.7%). Sample deterioration was also pointed out in another study which analyzed PARA at a national level[34].

Regarding factors related to sampling, the managers said that it is necessary to increase the number of food collections (58.3%). In the view of some of the health inspectors, there is little representation of the food consumed by the population in the state, because most of the time the collections are carried out in large commercial establishments (83.3%). Corroborating these findings, a study that analyzed the results of PARA-MG analyses between 2013 and 2017 pointed out that the sampling criteria used by PARA are unclear and the discontinuity in monitoring some crops makes it difficult to define a historical series of analyses of some foods in the state[12].

Regarding factors related to the actions of health control bodies, the quality managers said that consumers are largely unaware of the contamination of food by pesticide residues due to analysis results not being available (25.0%). They also reported that Health Surveillance needs to take more effective action on farmers (16.7%) and remove contaminated products from the market (16.7%). In turn, the majority of health inspectors cited not knowing the results of the analysis of the food collected as their main weakness (83.3%). It's worth pointing out that it's the state's responsibility to notify the reports resulting from the collections and to present the PARA-MG results annually to the municipal health surveillance bodies[9].

Although the PARA reports are available on Anvisa's website, the interviewees' statements show that the information is not disclosed systematically and transparently to health surveillance agencies, collection sites, and the population. Considering the risks inherent in exposure to pesticide residues, information on the presence or absence of these substances in food products is crucial for health control, as well as being a fundamental right of the consumer[35].

Among those interviewed, 61.1% of the quality managers and 66.7% of the health inspectors interviewed said that they were concerned about the presence of pesticide residues in food, while the rest did not answer or did not know how to answer. This result shows that even professionals working in the area of quality and sanitary control have a certain degree of insecurity about the possible risks of food contamination by pesticides.

Finally, it is worth noting that the PARA-MG regulations provide not only for the assessment of pesticide residue levels in food of plant origin on sale but also for the carrying out of educational or punitive health administrative procedures arising from problems identified under the program in the state[9].

CONCLUSIONS

The results show that there are weaknesses in compliance with traceability legislation for plant foods collected by PARA-MG, as information on previous and subsequent entities is often lost along the food production chain. The formation of consolidated batches in the centers that supply retailers is a critical point that makes it extremely difficult to identify the origin of the products, which compromises traceability and sanitary control actions on food contaminated by pesticide residues.

The study also revealed the existence of factors that hinder the traceability of plant foods, which seem to be related to: retail

companies, food suppliers, rural producers and inspection bodies. In addition, factors were identified that negatively interfere in the sanitary control of pesticide residues in food, including: operational factors, factors related to sampling and factors related to the actions of sanitary control bodies.

Considering the above, the findings point to the need not only to intensify the inspection and control of pesticide residues in food but also to: create measures to discourage and hold producers accountable for the inappropriate use of pesticides, bring the actions of health, agriculture and environmental inspection bodies closer together, develop policies aimed at valuing and certifying organic and agro-ecological production, promote good agricultural practices, reduce the distance between the producer and the retail chain, and encourage the implementation of traceability systems throughout the supply chain for fresh vegetable products.

Furthermore, as this was a non-probabilistic sample, the results of this study should not be generalized beyond the sample considered, but they do contribute to understanding the shortcomings involved in implementing PARA in the state of Minas Gerais. Therefore, future research is needed to assess the sampling criteria more clearly and the factors involved in both traceability and sanitary control of pesticide residues in food in the program at a national level.

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Authors' Contribution

Ribeiro MC - Conception, planning (study design), acquisition, analysis, data interpretation, and writing of the work. Ramos AM, Ferreira VA, Cunha JR - Data interpretation and writing of the work. Fante CA, Lucchese G - Conception, planning (study design), and writing of the work. All the authors approved the final version of the work.

Conflict of Interest

The authors inform that there is no potential conflict of interest with peers and institutions, political or financial, in this study.