ORGANIZATION OF BRAZILIAN FAMILY AGRICULTURE: THE DYNAMICS BETWEEN MANAGEMENT AND TECHNOLOGY

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Abstract

In recent years, many farmers and agroindustrial companies have focused on the advancement of agricultural technology, such as the fields of precision agriculture, which aims to improve current agriculture by ensuring lower production costs, greater efficiency, and significantly reduced environmental impact. Even yet, family farmers still face a number of challenges, including a lack of land, limited financial resources, a lack of professional assistance, and involvement in credit policy, in addition to having difficulty accessing technology and receiving the proper support from governmental policies. With the right training in how to manage the farm's processes, they can overcome the lack of technology and continue to produce in a way that is profitable and abundant. In Brazil, for example, family agriculture alone would rank as the eighth largest agro-producer in the world, according to the FAO report from 2016. In order to demonstrate how Family Agriculture can overcome the problems of the modern agricultural world, this article will use a specific management method (Lean Farm Management), to continually increase productivity, and cut waste without making significant investments in technology.

Keywords: Lean Farming, Rural Extension, Agriculture Management, Rural Technology

INTRODUCTION

For the past years, the development of technologies applied to agriculture have been the aim of many farmers and agroindustrial companies, where it is possible to highlight the fields of Precision Agriculture, aiming innovations that enhance the current agriculture, ensuring lower production costs, more efficiency, and considerably less environmental impact (Bucci et al., 2020). Several achievements have been accomplished, in special machines with non-human operation, animals with the ability to adapt to new environments, and GMO grains that have resistance to pests, disease and climate changes (Diao et al., 2016; Cassandro 2020; Phillips, 2008).

However, despite the big changes and good progress, when we focus more on family agriculture, the access to technology is not easy and public policies are not helping them as they should, the producers

also face several difficulties such as lack of land, financial resources, scarcity of technical assistance and participation in the credit policy (Souza et al., 2019). As it is explained in CENSOAGRO 2017, most of the small farmers only possess simple tractors and barely no access to highly specialized technology, such as GPS, precision irrigation, Controlled Storage Units and Sensors.

Even lacking in new technologies, their knowledge still makes the difference and with the proper instruction in how they can manage the processes from the farm, they can suppress the absence of technology and still make their production profitable and abundant – in Brazil, according to the FAO report from 2016, the family agriculture alone would be the 8th bigger agro-producer in the world.

Thus, this present article aims to present how Family Agriculture can overtake the challenges of the new world in agriculture; utilizing new management tools (as known as Lean Farm Management), and constantly improving production and reducing wastes without making big investments in technology.

MATERIALS AND METHODS

This research was done based on literature review from renowned sources and the available data from the Brazilian Agricultural Census (CENSOAGRO).

Definition of Lean Farm, based on several authors, such as Jana Hocken (2019), Rolo et al., (2014) and Fercoq et. al (2016), and the basics and principles of Lean Thinking Management, designed by Taiichi Ohno (in the Japanese Toyotism Era), and better explained by Womack et al. (2004). He says that Lean is a philosophy and a concept for production that wants to reach the lowest number of resources to produce the same product, focusing on the final value of it to the consumer.

Review of the Family Agriculture situation in Brazil and their current access to new technologies and public investment to afford them and be able to increase production.

For the assessment of Family Agriculture definition, it was based on Brazilian legislation and standards.

For new technologies showdown, applied scientific papers and journals were used to present an overview of them.

RESULTS AND DISCUSSION

Family agriculture in Brazil is important in socioeconomic proportions. Data from IBGE (2017) shows that this sector is responsible for 23% of the national agricultural and livestock production, with annual revenues of $55.2 billion. Family production represents the basis of the economy of 90% of the municipalities in the national territory that have up to 20 thousand inhabitants, guarantees the income of 40% of the economically active population of the country and ensures the income of more than 70% of workers in the field (Censo Agropecuário, 2017).

Considering the importance of this sector to Brazilian agriculture, it would be expected to have facilitated access to new technologies and more information. Unfortunately, Family Farmers encounter some difficulty to have access to new technologies and information, where rural extension could be an appropriate solution to counter this issue. However, by their unwillingness, their impossibility to afford or the lack of incentives from public institutions, it is difficult for family agriculture to have assistance (Jara-Rojas et al., 2020). Investments in rural extension can reach the increase of yields, still it is important to consider the needs and socioeconomic situation of the producer (Anderson, Feder, 2004). Furthermore, according to the results from Jara-Rojas (2020) in his studies, it shows that farmers with higher adoption indexes – translating, longer extension visits – had a greater number of group activities (i.e., group meetings and field days), and greater use of incentives and credit provided by INDAP.

The lack of technology on family farming properties, according to Alves & Souza (2015), comes not only from market imperfections, but also from produced and commercialized volume, since it limits the

bargaining power of these producers and does not open margin for high profits, preventing the acquisition of new technologies. In addition, there are other factors that can limit the access to them, such as schooling, place of residence, difficulties of bank registration and access to public and private financing (Souza et al., 2019).

Lean is a Japanese philosophy that aims to optimize production, so that with fewer resources and activities, more is produced, eliminating waste in the production process, according to Dennis (2015). According to Hartman (2015), Lean Farm is the applicability of philosophy in farms, optimizing the processes of agriculture and animal husbandry.

Limère et. al. (2016) states that farmers frequently lacked a good understanding of the issues that mattered to their customers, not only because the client is the central character in Lean thinking, it is vital to define the customer value, but it is critical to ensure that the work force understands what Lean is and is aware of waste removal to accomplish successful Lean implementation. This problem can be solved by employee training and encouragement. Employees must be given more power, and resistance to change must be overcome. Another challenge is determining the financial value produced by Lean processes. None of these actions would require huge technological investments.

The ideal management of rural property can optimize productivity, since by applying management methodologies such as Lean, waste can be eliminated. According to Deshmukh (2021) small producers do not have the financial resources to invest in all equipment that involves agricultural production, such as seeder, fertilizer, among others, thus proposing that the Lean Farm focus on the construction of multifunctional equipment aiming at low cost. The author brings as an alternative the design of a human-operated machine that can be used for land preparation, sowing, fertilization and land leveling.

CONSIDERATIONS

Agriculture is fundamental for the Brazilian economy, so every new perspective to increase productivity and enhance the farm should be valid. Family farmers, despite limited access to new technologies, can benefit from the application for Lean Philosophy in their farms, where they would increase production by investing in management tools, reducing the wastes from all the farm's processes, thus reducing the production price of the product – but still selling for the same price.

According to recent research, Lean Thinking approaches could help boost agricultural productivity (Colgan et al., 2013 and Taylor, 2006). Furthermore, studies from Standard & Davis (2000), Zokaei & Simons (2006) and Rougoor et al. (1998) shows that there is no reason why agriculture cannot embrace Lean Management principles, as the method has proven to be adaptable to a variety of different industries. With some adjustments and proper instruction, in the first moment, no technology would be needed, making it possible for any type of producer to apply.

Finally, the Lean Philosophy would be a turn around for the lack of technology that small producers have in comparison to big commodities companies, making it possible for them to manage their farms in a proper way.

PRESENTATION: https://youtu.be/5k0b5Yced-Y

REFERENCES

ALVES, E; SOUZA, G. S. Pequenos estabelecimentos também enriquecem? Pedras e tropeços. **Revista de Política Agrícola**, 2015.

ANDERSON, J. R; FEDER, G. Agricultural Extension: Good Intentions and Hard Realities. **The World Bank Research Observer**, v.19, p. 41-60, 2004.

BUCCI, G. et al. Measuring a farm's profitability after adopting precision agriculture technologies: A

case study from Italy. **ACTA IMEKO**, v. 9, n. 3, p. 65-74, 2020.

CASSANDRO, M. Animal breeding and climate change, mitigation and adaptation. **Journal of Animal Breeding and Genetics**, v.137, 2020.

CENSO AGROPECUÁRIO, IBGE. **Censo agropecuário, disponível na Biblioteca do IBGE**. Brasil, 2017.

COLGAN, C; ADAM, G; TOPOLANSKY, F. Why try Lean? A Northumbrian farm case study. **International Journal of Agricultural Management**, v.2, 2013.

DESHMUKH, G. P. et al. Lean Farming: Design and Fabrication of Multipurpose Agro Machine. **Strad Research**, v. 8, 2021.

DIAO, X; SILVER, J; TAKESHIMA, H. Agricultural Mechanization and Agricultural Transformation. **African Transformation Report**, 2016.

DENNIS, P. LEAN PRODUCTION SIMPLIFIED: A Plain-Language Guide to the World's Most Poweful Production System. 2015. FERCOQ, A; LAMOURI, S; CARBONE, V. Lean/Green integration focused on waste reduction techniques. **Journal of Cleaner Production**, v. 137, 2016.

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS, FAO. **The State Of Food And Agriculture**, 2016. HARTMAN, B. The Lean Farm: How to Minimize Waste, Increase Efficiency, and Maximize Value and Profits with Less Work. 2015. HOCKEN, J. The Lean Dairy Farm: Eliminate Waste, Save Time, Cut Costs-Creating a More Productive, Profitable and Higher Quality Farm. **John Wiley & Sons**, 2019.

JARA-ROJAS, R. et al. Technology Adoption and Extension Strategies in Mediterranean Agriculture: The Case of Family Farms in Chile. **Agronomy**, 2020.

LIMÈRE, V; DORA, M. **Developing A Readiness Index Forlean Practices In Agriculture**. 2016.

OHNO, T. Toyota production system: beyond large-scale production. Cambridge: **Productivity Press**, 1988.

OHNO, T. The Toyota Production System – beyond large-scale production. **Porto Alegre: Medical Arts**, 1997.

PHILLIPS, T. Genetically Modified Organisms (GMOs): Transgenic Crops and Recombinant DNA Technology. **Nature Education**, v.1, 2008.

ROLO, A;PIRES, A.R; SARAIVA, M. Supply chain as a collaborative virtual network based on a large strategy. **Advances in Intelligent Systems and Computing**, v. 280, 2014. ROUGOOR, C. W. et al. How to define and study farmers' management capacity: theory and use in agricultural economics. **Agricultural economics**, v. 18, 1998.

SIMONS, D; ZOKAEI, K. Performance Improvements through Implementation of Lean Practices: A Study of the U.K. Red Meat Industry. **International Food and Agribusiness Management Review**, v. 9, 2006.

SOUZA, P. M. et al. Diferenças regionais de tecnologia na agricultura familiar no Brasil. **Revista de Economia e Sociologia Rural**, v. 57, 2019.

STANDARD, C; DAVIS, D. Lean thinking for competitive advantage. **Automotive Manufacturing and Production**, v. 12, n. 1, 2000.

TAYLOR, D. H. Strategic considerations in the development of lean agri-food supply chains: a case study of the UK pork sector. **Supply Chain Management: An International Journal,** 2006.

WOMACK, J. P. The Machine That Changed the World. **Gulf Professional Publishing**, 2004.

PRODUCTION OF GRANULATED ORGANOMINERAL FERTILIZER FROM SWINE WASTE

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Abstract

The search for alternative sources of phosphorus in agriculture has been widely studied in the world due to imminent future scarcity and geopolitical issues. The production of organomineral fertilizers from agro-industrial residues has been used in Brazil, due to the added economic and environmental benefits. However, studies on the subject are still preliminary. Therefore, the objective of this work is to evaluate the effects of mineral and organomineral fertilization on corn. Ten formulations were produced with different proportions of monoammonium phosphate (MAP) and thermophosphate. An experiment was installed in a greenhouse. The experimental design was in randomized blocks, using four treatments, two mineral sources, with four replications, in addition to the control without fertilization. The experimental units used were plastic pots containing 1 kg of Red Yellow Argisol. The experiment was carried out for up to 45 days. At the end, the aerial part of the plants was collected and, after cutting, the samples were taken to the forced air circulation oven at a temperature of 65 ºC for 72h. Then, weighing, grinding and nutrient content were determined. After the Tukey test, it was concluded that for the variables dry weight and fresh weight, the treatments produced from MAP did not diverge from each other, while the treatments produced with thermophosphate also did not diverge from each other and were similar to the control without fertilization. The organic carbon variable did not show significance in the analysis of variance.

Keywords: Phosphate; swine litter; by-product

INTRODUCTION

Phosphorus, together with nitrogen and potassium, make up a trio of essential nutrients for plants, used to ensure the good yield of agricultural crops (PANTANO, 2016). The main P input for agricultural soils comes from manure, agricultural by-products and mineral fertilizers (KRUSE et al. 2015), the latter being considered a non-renewable resource because it is obtained from phosphate rock dust. In Brazil, the application of phosphate fertilizers is an indispensable practice in agricultural areas, since most Brazilian soils have low levels of phosphorus available to plants (FRAZÃO JR; LAVRES; BENITES, 2021). In recent years, the issue of P availability for crops has been the subject of significant societal concern, resulting in considerable research efforts on all aspects of the issue (BAVEYE, 2015). One of the solutions studied for the reuse of phosphorus is the energy use of agricultural residues, including that from swine production. The management of resources in swine farming aims to minimize the environmental and economic impacts of the activity. As it is a highly polluting activity, waste management is one of the main challenges in the sector (ITO, et al., 2016). Recently, organomineral fertilizers produced from the association of swine manure with mineral sources, in fluid and granular forms, have been studied regarding the supply of nutrients in crops, showing promising results (CASSOL, 2012; GROHSKOPF, 2020). However, few studies have been carried out specifically on

the supply of phosphorus after the use of granulated organomineral fertilizers produced from swine manure in Brazil. This work aims to analyze the results obtained after the analyzes proposed in the methodology and to evaluate the use of the final product in the organic production system, since mineral sources allowed in organic agriculture by the current legislation were tested.

MATERIALS AND METHODS

Fertilizer production

The products were granulated at the Embrapa Solos Fertilizer Laboratory, based on the defined formulations. The granulation process was batched on a plate with constant rotation and inclination.

Analysis of total P, C, N and Cation exchange capacity (CTC) of fertilizers

The P_2O_5 content was determined by the Quimociac gravimetric method, from the Manual of Official Analytical Methods for Fertilizers and Correctives (MAPA, 2017). The content of C and N will be determined according to the methodology of Dumas (KEENEY and BREMNER, 1967). In determining the CTC, the calcium acetate method with titration with NaOH will be used.

Potted experiment

Chemical and physical analyzes of the soil

A sample was collected at a depth of 0 to 30 cm from a Red Yellow Argisol at Embrapa agrobiologia in Seropédica-RJ. The physical and chemical analyzes of the soil were performed according to the Embrapa method (TEIXEIRA et al., 2017). The pH of the sample suspension was measured, following the Guidelines of the Soil Analysis Method Manual. (EMBRAPA, 2017)

Implementation of the experiment

The experiment was carried out in a greenhouse at Embrapa Agrobiologia, in Seropédica, RJ. The treatments were 100g/kg of each organomineral fertilizer –T1, T10, T11 and T20-, in addition to thermophosphate and monoammonium phosphate (MAP). The experimental design was randomized blocks, using a dose of phosphorus, with four replications, in addition to the control without fertilization. The experimental units used were plastic pots containing 1 kg of Red Yellow Argisol soil. A nutrient solution with micronutrients was added to all pots. Six seeds were placed in each pot, and five days after emergence, thinning was performed, leaving two plants per pot. The experiment was carried out for up to 45 days. At the end, the aerial part of the plants was collected and, after cutting, the samples were taken to the forced air circulation oven at a temperature of 65 ºC for 72h. Then, weighing, grinding and determination of nutrient contents were performed using methodologies described by Carmo et al. (2000). At the end of the experiment, the soils in the pots were dried, crushed and sieved, and will be analyzed for their fertility, according to Teixeira et al. (2017). The data obtained were submitted to analysis of variance, and to the Tukey test, with the aid of SISVAR statistics software (Ferreira, 2014).

RESULTS AND DISCUSSION

Fertilizer production

Formulation Granulated organomineral fertilizers were produced from swine manure using two distinct mineral sources, monoammonium phosphate (MAP) and thermophosphate, with respective agronomic guarantees of 60% and 17%. Thermophosphate is one of the sources of phosphorus that can be used in organic agriculture (VITTI et al, 2003). The formulations produced are detailed in table 1.

Table 1: Formulations produced from swine manure compost.

Formulations	compost (g)	MAP (g)	Termofosfato (g)	KCl(g)	K2SO4(g)	MgO (g)	Bentonita (g)	Silicato de Potássio (g)	Micronutrients (g)			Total (g)
									ZnSo4	CuSO4	H3Bo3	
T1	129,3	129,3	-	41,4	-	-	-	-			-	300
T2	117,6	117,6	-	41,4	-	-	-	-	13,2	5,91	4,32	300
T3	114,3	114,3	-	41,4	-	30	-	-	-	-	-	300
T4	102,6	102,6	-	41,4	-	30	-	-	13,2	5,91	4,32	300
T5	147	147	-	-	-		6	-	-	-	-	300
T6	148,5	148,5	-	-	-		-	3	-	-	-	300
T7	147	147	-	-	-		-	6	-	-	-	300
T8	145,5	145,5	-	-	-		-	9	-	-	-	300
T9	144	144	-	-	-		-	12	-	-	-	300
T10	98	98	-	41,4	-	30	6	3	13,2	5,91	4,32	300
T11	126	-	126	-	48	-	-	-	-	-	-	300
T12	114,3	-	114,3	-	48	-	-	-	13,2	5,91	4,32	300
T13	111	-	111	-	48	30	-	-	-	-	-	300
T14	99,2	-	99,2	-	48	30	-	-	13,2	5,91	4,32	300
T15	147	-	147	-	-	-	6	-	-	-	-	300
T16	148,5	-	148,5	-	-	-	-	3	-	-	-	300
T17	147	-	147	-	-	-	-	6	-	-	-	300
T18	145,5	-	145,5	-	-	-	-	9	-	-	-	300
T19	144	-	144	-	-	-	-	12	-	-	-	300
T20	95	-	95		48	30	6	3	13,2	5,91	4,32	300
Total	2476,3	1195,8	1277,5	207,0	192,0	150,0	18,0	63,0	66,0	29,6	21,6	5699,8

Total P analysis

Total P analyses, expressed in P_2O_5, were performed in duplicate and the results are shown in table 2. The minimum guarantees presented in the third column were calculated from the agronomic guarantees presented by the manufacturers of commercial mineral fertilizers, applied to the following formula:

$$G\% = (A \times B) / C,$$

Where:

G%: Guarantee calculated;

A: Mineral fertilizer mass used in the formulation;

B: Commercial guarantee of the mineral fertilizer used in the formulation,

C: Total mass of the organomineral fertilizer produced.

Table 2: Result of the analysis of total P and the calculated guarantee of all formulations produced

Formulations	Average (%)	Guarantees (%)
T1	39,47	25,86
T2	29,42	23,52
T3	23,87	22,86
T4	30,57	20,52
T5	30,43	29,40
T6	36,85	29,70
T7	30,11	29,40
T8	40,37	29,10
T9	33,87	28,80
T10	20,10	19,60
MAP	65,70	60
T11	7,66	7,14
T12	7,41	6,48
T13	7,87	6,29
T14	6,00	5,62
T15	8,27	8,33
T16	9,22	8,42
T17	9,26	8,33
T18	9,37	8,25
T19	8,11	8,16
T20	5,62	5,38
Termofosfato	17,35	17

The results obtained demonstrate that the P_2O_5 concentration of MAP were significantly better than the control. Treatments T1, T4 and T8 stood out with a significant increase in P_2O_5.

Potted experiment

Chemical and physical analyzes of the soil

The result of the chemical analysis of the soil is presented in table 3 and the physical analysis in table 4.

Table 3: Result of the chemical analysis of the soil before the implantation of the experiment.

	pH H_2O	Aluminum	Calcium	Magnesium	sodium	Potassium
	1:2,5	cmolc/dm^3	cmolc/dm^3	cmolc/dm^3	cmolc/dm^3	cmolc/dm^3
sample	pH H_2O	Al	Ca	Mg	Na	K
1	5,7	0,1	0,6	0,1	11,5	18,72
2	5,8	0,1	0,5	0,1	11,5	18,72
3	5,2	0,1	0,6	0,1	11,5	17,55

	Total acidity	Phosphor	S value	T value	V value	organic carbon
	cmolc/dm^3	mg/dm^3	cmolc/dm^3	(%)		g/Kg
sample	Total acidity	Phosphor	S value	T value	V value	organic carbon
1	0,99	7,82	1,35	2,34	57,66	3,42
2	0,99	6,32	1,15	2,14	53,70	3,28
3	1,155	6,04	1,35	2,50	53,80	3,60

According to the parameters presented in the Manual of Liming and Fertilization of the State of Rio de Janeiro (Freire et al., 2013) we can conclude that it is a moderately acidic soil, with a low level of aluminum, low amount of Ca and Mg, low concentration of organic carbon and low level of P and K.

Table 4: Result of the physical analysis of the soil before the implementation of the experiment

Sample	Coarse Sand	Fine Sand	Clay	Silt
1	608	276	40	76
2	642	248	40	70
3	638	246	40	76

Collection of the experiment in vase

The fresh and dry weights of the aerial part of each sample collected in the pot experiment, and the result of the soil organic carbon analysis of each pot are presented in table 5.

Table 5: Fresh and dry weights of corn shoot samples and soil organic carbon from each experiment pot.

Vase	Formulations	Repetition	Fresh Weight (g)	Dry weight (g)	C org. g/kg
1	Testemunha	1	39,4486	6,1726	2,4
2		2	38,9546	7,7096	2,9
125		3	31,7346	4,6986	2,8
13	Termofosfato	1	41,6576	7,3506	2,4
14		2	39,1106	7,3586	2,1
16		3	44,4096	8,8946	2,6
21	MAP	1	66,0616	12,6996	2,4
22		2	61,6306	12,4896	3,1
23		3	68,0236	12,7306	2,4
33	T1	1	54,6486	8,7476	1,9
34		2	66,0396	12,2126	2,1
35		3	67,6606	12,7646	2,3
37	T10	1	74,0086	12,7776	2,2
39		2	70,9906	11,5886	2,4
40		3	73,1816	13,5556	1,9
41	T11	1	45,6846	7,7946	2
43		2	42,0816	7,0226	3,8
44		3	45,3766	8,1366	1,9
45	T20	1	21,1916	3,0406	2,5
46		2	14,8496	2,2556	2,7
48		3	23,6706	3,4826	2,6

The remaining nutrient analyzes are still in progress. The variables were submitted to analysis of variance (F test, Pr<0.05). There was a significant effect of the treatment variation effect for the fresh weight and dry weight variables. The organic carbon variable did not show significance. The comparison between the means was made by the Tukey Test with the aid of SISVAR statistics software (Ferreira, 2014).

Fresh arrested

Based on the data, when analyzing the fresh weight variable, we observed that monoammonium phosphate did not differ statistically from T1 and T10, while T11 did not differ from the control and thermophosphate, and T20 showed a lower mean, different from the other treatments (Table 6). T1 and T10 are treatments composed of different proportions of compost and monoammonium phosphate, with T10 being the formulation with the lowest contribution of compost and mineral fertilizer, and with the highest average fresh weight. T11 and T20 are treatments formulated with thermophosphate as a mineral phosphate contribution, with T20 having the lowest contribution and T11 having the highest contribution.

Table 6: Tukey test result with the Fresh Weight variable.

Formulations	Fresh Weight (g)	
Testemunha	36,71	B
T1	62,78	A
T10	72,73	A
T11	44,38	B
T20	19,9	C
MAP	65,24	A
Termofosfato	41,73	B
Average	490,67	

Dry Weight

Based on the data, when analyzing the dry weight variable, we observed that monoammonium phosphate did not differ statistically from T1 and T10, while T11 did not differ from the control and thermophosphate, while T20 presented a lower mean, not differing from the control and differentiating it from the other treatments. (Table 7).

Table 7: Tukey test result with the Dry weight variable.

Formulations	Dry weight (g)	
Testemunha	6,19	BC
T1	11,24	A
T10	12,64	A
T11	7,65	B
T20	2,93	C
MAP	12,64	A
Termofosfato	7,87	B
Average	8,74	

CONSIDERATIONS

Considering the averages of P_2O_5 from the results of the total P analyzes and the guarantees calculated for each treatment, we can conclude that treatments T1, T4 and T8 had a significant increase in P_2O_5. No treatment with thermophosphate had a significant increase in P_2O_5. Analyzing the dry weight and fresh weight data, we can observe that the treatments composed of monoammonium phosphate were statistically similar to each other and to the mineral fertilizer. While the treatments composed of thermophosphate were similar to each other and to the control, demonstrating a low contribution of P to the plant.

PRESENTATION: https://youtu.be/SEC5xQxNIo8

REFERENCES

Baveye, P.C. 2015. Looming scarcity of phosphate rock and intensification of soil phosphorus research.

Revista Brasileira de Ciência do Solo 39: 637-642, 2015.

CARMO, Ciríaca Arcangela Ferreira de Saldanha; ARAÚJO, Wilson Sant'Ana de; BERNARDI, Alberto Carlos de Campos; SALDANHA, Marcelo Francisco Costa. Métodos de Análise de Tecidos Vegetais Utilizados na Embrapa Solos. Embrapa Solos. Rio de Janeiro**. Circular Técnica, n.6**, 41p. 2000.

Cassol PC, Costa AC, Ciprandi O, Pandolfo CM, Ernani PR. Disponibilidade de macronutrientes e rendimento de milho após aplicações de dejetos de suínos em um latossolo vermelho. **Rev Bras Ciênc Solo** 36: 911–1923. 2012.

Embrapa,: **Manual de métodos de análise de solo** / Paulo César Teixeira ... [et al.], editores técnicos. – 3. ed. rev. e ampl. – Brasília, DF, 2017.

FERREIRA, D. F. Sisvar: a Guide for its Bootstrap procedures in multiple comparisons. **Ciência e Agrotecnologia** 2014, 38, 109.2014.

FRAZÃO, Joaquim José; LAVRES, José Junior; BENITES, Vinicius de Melo. Mudanças nas frações lábeis de fósforo no solo em função da aplicação de fertilizantes minerais e organominerais fosfatados. In: Oliveira, Antonella Carvalho (ed). **Sistemas de Produção nas Ciências Agrárias.** Ponta Grossa-PR: Atena. p. 156-160, 2021.

FREIRE. **Manual de Calagem e Adubação do Estado do Rio de Janeiro** / Editor técnico, Luiz Rodrigues Freire... [et al.].- Brasília, DF: Embrapa ; Seropédica, RJ : Editora Universidade Rural, 2013

GROHSKOPF, Marco André et all. Eficiência de fertilizante fluido organomineral com dejeto suíno na disponibilidade de nitrogênio e fósforo. **Rev. Ciênc. Agrovet**., Lages, SC, Brasil (ISSN 2238-1171). v. 19 n. 1. P. 84-93. 2020

ITO ; GUIMARÃES ; AMARAL. **Impactos ambientais da suinocultura:desafios e oportunidades. Agroindústria: BNDES Setorial** , p. 125-156, 2016.

KEENEY D.R., BREMNER J.M. Use of the Coleman model 29. A analyser for total nitrogen analysis of soils. **Soil Science,** v.104(5), p. 358-363, 1967.

Kruse J, Abraham M, Amelung W, Baum C, Bol R, Kühn O, Lewandowski H, Niederberger J, Oelmann Y, Rüger C, Santner J, Siebers M, Siebers N, Spohn M, Vestergren J, Vogts A, Leinweber P Métodos inovadores em pesquisa de fósforo no solo: uma revisão. **J Plant Nutr Soil Sci**.; 178: 43-88, 2015.

MAPA. Ministério da Agricultura, Pecuária e Abastecimento. **Manual de métodos analíticos oficiais para fertilizantes e corretivos** / Ministério da Agricultura, Pecuária e Abastecimento. Secretaria de Defesa Agropecuária, 2017.

PANTANO, G.; GROSSELI, G. M.; MOZETO, A. A.; FADINI, P. S. Sustentabilidade no uso do fósforo: uma questão de segurança hídrica e alimentar. **Química Nova**, v. 39, n. 6, p. 732-740, 2016.

TEIXEIRA, P. C.; DONAGEMMA, G. K.; FONTANA, A.; TEIXEIRA, W. G. **Manual de métodos de análise de solo**. 2ª ed. rev. e ampl. Brasília, DF, 2017.

VITTI, G.C., WIT, A., FERNANDES, B.E.P.: Eficiência agronômica dos termofosfatos e fosfatos alternativos. In: **SIMPÓSIO FOSFORO NA AGRICULTURA BRASILEIRA, 2003, São Pedro. Anais.** São Pedro: Potafos; ANDA, 2003. 726p.

SCHOOL GARDENS: CREATION OF A MODEL SCHOOL AT THE VINICIUS DE MORAES MUNICIPAL CHILD EDUCATION UNIT (UMEI)

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Abstract

The project to implement school gardens comes from the Program for the Development of Applied Projects (PDPA) in the municipality of Niterói, in the state of Rio de Janeiro. Thus, to contribute to this program, the aim was to elaborate a pilot school garden implementation was proposed in the Vinicius de Moraes Municipal Child Education Unit (UMEI), seeking the insertion of environmental contact in all phases, from implementation to harvesting of a garden, in order to become a pedagogical garden for early childhood education, as a model of instruction, focused on environmental education, food and nutrition. For this, six beds were prepared, including a spiral one for growing vegetables. After this initial phase, a analysis was made about the period the food was harvested back to the school. In addition to the food aspect, we also tried to grow sunflower in all the beds, in combination with the food plants, as a source of green manure. The UMEI Vinicius de Moraes presented a great acceptance of the proposed model by teachers and students, besides being recognized by the community, serving as a model for other schools, including in local reports highlighting the activity as a model. After the sucess of this model, we intend to expand it to other schools.

Keywords: Environmental education; Public school; School model;

INTRODUCTION

The National Policy for Environmental Education, established by Law N°9795 of April 27, 1999, encourages environmental education in schools so that is an essential and permanent component of school environments, present at all levels. For this, it is necessary that public schools seek to bring this contact with nature in the best possible way into the student's daily routine. The National School Feeding Program in its documents proposes the garden as a tool for food and nutrition education, in order to discuss with the school community issues about the food system, food culture, among others

(BRASIL, 2020). In view of these guidelines, the Healthy and Sustainable Schools project is part of the Program for the Development of Applied Projects (PDPA), which is a partnership between the City of Niterói and the Fluminense Federal University (UFF).

The partnership described above is important, because the school environment can be considered one of the places where future citizens will take the first steps towards their awareness of environmental care. It is at school that the student will continue the socialization process started at home and, therefore, it has an important role with regard to the process of both social and environmental formation of students (SILVA and BEZERRA, 2017). In this sense, aiming to show how school environmental education is of paramount importance for the development of the human being, the PDPA educational gardens program seeks to bring a direct and immediate contact of students with the environment and the community in which they are inserted.

Thus, it was proposed the creation of a Pilot School for the implementation of school gardens in the Municipal Child Education Unit Vinicius de Moraes (UMEI), seeking the insertion of environmental contact in all phases, from implementation to the harvest of a garden, in order to become a pedagogical garden for early childhood education, in order to create an instructional model, focused on environmental education, food and nutrition

MATERIALS AND METHODS

The creation of a Pilot School for the implementation of school gardens was in the Unidade Municipal de Educação Infantil Vinicius de Moraes (UMEI), located in the Sapê neighborhood in the municipality of Niterói, in the state of Rio de Janeiro. The school includes students of Kindergarten and Elementary School I, the study began in September 2021, analysis and application of this project was until September 2022, and the activities are still ongoing in the space.

The space available for the development of the project was located in the upper part of the school where there was already an arrangement of some beds that were not being used as shown in Figure 1. Of these, two beds were used, where the larger one was divided in two, for the layout of the vegetable garden, besides the creation of a third spiral bed built with eucalyptus donated by the community.

Bed four had an area of approximately 8.8m² where the depth is 0.35m, beds one and three had an area of 3.11m² and 7.58m² respectively. In bed one there was a jackfruit tree, which was a limiting factor for the choice of species to be grown.

From the crops chosen, seedlings were purchased for planting, which initially occurred on 06/22/2022 and 06/23/2022 in beds one and three, with the presence of everyone involved in the project. For the preparation of beds four, five and six the crops chosen were germinated and grown in the schools with the help of farmers and students, and transplanted on 30/06/2022. Bed six received its seedlings transplanted on 07/06/2022.

The crops chosen for each bed are listed in Frame1 below, considering the use of spices by the school for the preparation of the daily meals and respecting the jackfruit root that is close to beds one and three. In the fourth bed, which was a project, cultures were chosen considering the needs of the school and the quality of contact of the children. It is important to note that in addition to these crops, sunflowers were planted in all the beds, which is an excellent plant to be used as green manure, as reported by Silva et al, 2021.

Figure 1: Layout of the beds

Source: Elaborated by the author

Frame 1: Crops grown by beds

	Quantity Planted seedbed 1	Quantity Planted seedbed 2	Quantity Planted seedbed 3	Quantity Planted seedbed 4	Quantity Planted seedbed 5	Quantity Planted seedbed 6
Chard	1	3		1		
Curly Lettuce	11		9	1	10	2
Plain Lettuce	1	1	7			
Purple Lettuce	3			2		
Garlic		1				
Chicory		1				
Purple Chicory			7	2	11	1
British		3				
Scallion		8	4		14	
Carrot			2	4		
Endive				3	6	
Curly Endive			7			
Cilantro		6			2	
Green Cabbage		4	7	8	9	
Spinach			1		17	
Basil		2		5		
Purple Basil			1			
Passion Fruit		1		1	2	
Mustard			13	1	5	
Oregano			12	4	7	3
Purple Savoy			6	6	4	5
Arugula	18	12				
Parsley		15		23	22	
Little Parsley	4					
Curly Little Parsley			12		8	
Tomato				2		
Total	38	57	88	63	117	11

Source: Elaborated by the author

RESULTS AND DISCUSSION

The project was based on the need to bring urban agriculture into students' daily lives in order to focus on environmental education in addition to food and nutritional security. Urban school gardens can facilitate, for the teacher and for the students, the perception of the interfaces agriculture-environment-food habits, inserted in the fields of Environmental Education and Health Education (According to Silva and Fonseca, 2012).

To start the project was necessary the installation of protective railings above the flowerbed four as can be seen in Figure 2, these railings were installed by the municipality since the space is high and was dangerous for students and employees. With this division, the students have access to beds one and

three, and to the spiral vegetable garden, and the school professionals have restricted access to bed four because the protection grid at the bottom is lower.

Figure 2: Installation of the Guard Rails

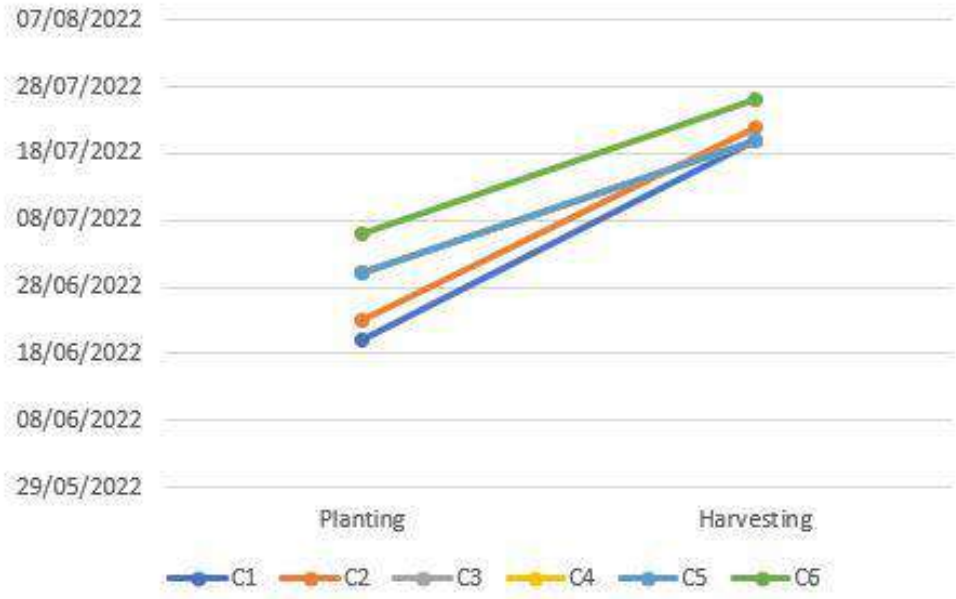
Source: Elaborated by the author

With the installation of these grids, another space was created that could be used for the creation of a fourth smaller bed that was designed to be 20 cm from the grid. This smaller bed facilitated even more contact by the students, who are children up to seven years old, and because it is on the ground they can more easily harvest and irrigate.

Children's participation in the space started from the very first moment when they interacted with the space workers asking questions about how and when the garden would be ready. With the implementation of the trellis the students participated in all the processes, such as transplanting the seedlings to the bed, irrigating, and harvesting the ripe vegetables. This strengthened the students' understanding of where food comes from, and stimulated their interest in trying new and diverse vegetables.

As shown in Figure 3 below, bed one was planted on 06/20/22 and had its first harvest on 07/20/22, while bed six, the last to be planted, had its first harvest on 07/26/22. The beds three, four and five had the same planting and harvesting cycle and for this reason their rows overlapped, while bed six had the same duration of cycle, twenty days, for the harvest of the crop they all had in common, which was oregano, this one having a shorter cycle. While beds one and two, which had more diversified vegetables, needed a slightly longer period for harvesting.

Figure 3: Planting x First Haversting of seedbeds



Source: Elaborated by the author

The school has already gone through the process of more than one harvest, and the cycle of these harvests is maintained with the help of students and teachers. In Figures 4 a and b below, one can observe a harvest day with the interaction of students, which has become a regular activity for them, respecting the needs of each crop. This frequent harvest helps the variety offered by the school, and the students have contact with foodstuffs that they will consume in school meals.

Figure 4: Harvesting the vegetable garden front view including all beds (a); Top view of the spiral bed (b).

Source: Elaborated by the author

CONSIDERATIONS

The garden has become a powerful tool for environmental, food, and nutritional education for the entire school community. The students at UMEI Vinicius de Moraes showed a great acceptance of the insertion of the garden into their daily lives, improving their receptivity to different foods. The presence of the garden in an urban environment brought students and teachers into closer contact with fresh food, helping to reduce waste and encouraging the production of food with higher added nutritional value.

Although the project had started a year earlier, from the moment of the construction of the beds and planting, it was shown that a school garden is extremely efficient to help with the internal feeding, because besides reducing costs there is a fast return considering its first harvest. In addition, the school

gardens initiative has already gained great recognition in the city, with the UMEI Vinicius de Moraes being headlined as a model school, according to the newspaper O Fluminense, 2022.

PRESENTATION: https://youtu.be/yX4pgIVF2i8

REFERENCES

BRASIL. Ministério da Educação. Fundo Nacional de Desenvolvimento da Educação. Resolução no 6, de 8 de maio de 2020. Dispõe sobre o atendimento da alimentação escolar aos alunos da educação básica no âmbito do Programa Nacional de Alimentação Escolar -PNAE. **Diário Oficial da União**: seção 1, Brasília-DF, n.89, p.38, 12 mai 2020.

Lei de Política Nacional de Educação Ambiental**, L9795**. Planalto.gov.br. Disponível em: . Acesso em: 13 out. 2022.

SILVA, HELOINA O. da; BEZERRA, RENILTON D. 2017. A importância da educação ambiental no âmbito escolar. **Revista Interface**, v. 12 n. 12.

SILVA, E. C. R., & FONSECA, A. B. 2012. Hortas em escolas urbanas, Complexidade e Transdisciplinaridade: Contribuições para a Educação Ambiental e para a Educação em Saúde. **Revista Brasileira De Pesquisa Em Educação Em Ciências,** 11(3), 35–54.

SILVA, GENILTON T.; PEREIRA, MARIA R. R.; SILVA, RAFAEL J. N. da. 2021 Influência do girassol na ocorrência de plantas infestantes em área de preservação permanente. **Diversitas Journal**, v. 6, n. 2, p. 1989–1998.

Educação sem limites na rede pública municipal de Niterói. Disponível em: https://www.ofluminense.com.br/cidades/niteroi/2022/10/1257784-educacao-sem-limites-na-rede-publica-municipal-de-niteroi.html. Acesso em: 17 outubro 2022.

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SENSOR CONTROL OF A PROTOTYPE SILO USING ARDUINO

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Abstract

Arduino emerged from a professor's need to fulfill an academic demand for low-cost boards. Arduino designs, manufactures, and supports electronic devices and software, allowing people around the world to easily access advanced technologies that interact with the physical world. According to the manufacturer, Arduino's mission is to enable anyone to improve their life, through accessible electronics and digital technologies, by having an infinite range of compatible sensors, making it a great ally of projects, mainly because it is low cost. In order to automate and monitor factors such as temperature, relative humidity and pressure, a prototype silo was used, counting on the installation of an Arduino board together with sensors capable of collecting and transmitting this information to a data collection system. From the collected information, it becomes possible to monitor the stored products, as well as provide conditions for better decision making, analogous to a real situation. Applying this automation system, in a prototype of a small scale silo, it is admissible to transform the didactics of the subject more accessible to the classroom, exactly because of its small dimensions and accessible material. In this context, this project aimed to use the Arduino as a tool to obtain accurate and safe measurements of temperature, humidity and pressure inside a silo prototype.

Keywords: Data acquisition system; temperature; humidity; BME280

INTRODUCTION

Arduino was created in 2005 by Professor Massimo Banzi in Italy. Banzi wanted to teach his students programming and electronics concepts, however access to the boards was limited and they were of high purchasing value, which would make it difficult for his students to acquire the product. In this way, together with other researchers, they had the idea of creating a device that was both low-cost and easy to program, being accessible to students and amateur designers (GRUPO DE ROBÓTICA - UFMS,

2012).

According to McRoberts (2015), in structuring the Arduino, the concept of free hardware (open hardware) was adopted, allowing free access to the entire population. Thus, it is possible to assemble, modify, improve and customize from the same basic hardware project. Arduino is a low-cost hardware, with several features, which allows the use of sensors for designing projects. Due to the open hardware, the Arduino is very useful in low-cost projects, including the small-scale silo project, where it will be necessary to measure temperature, relative humidity, and pressure for grain storage. In this scenario, low-cost sensors such as BME280 prove to be great allies for carrying out such tasks.

The present work aims to use Arduino to automate the process of measuring the temperature, relative humidity, and pressure of a silo prototype.

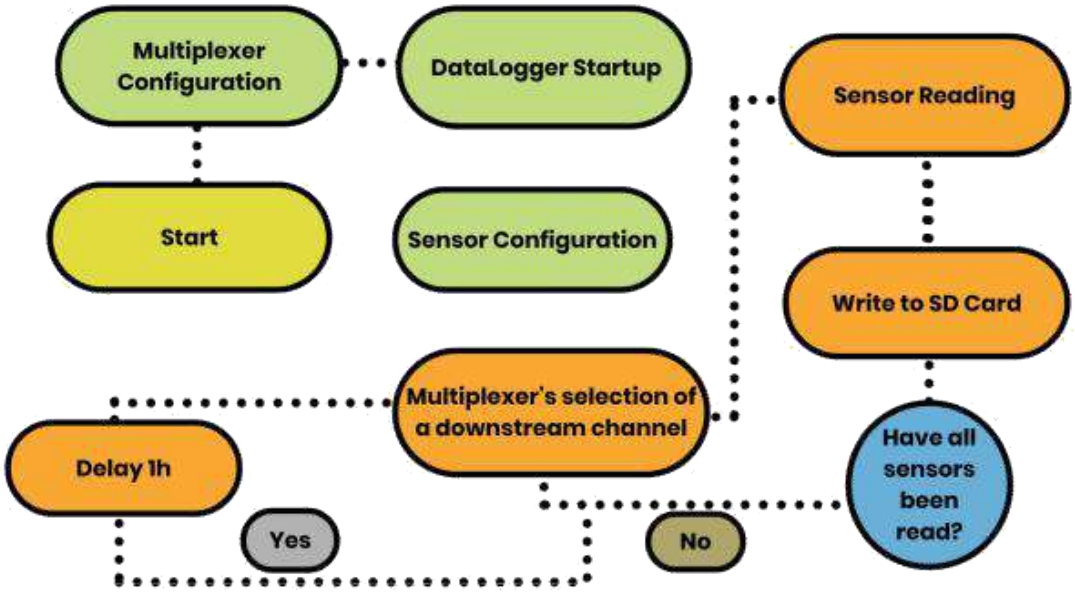
MATERIALS AND METHODS

The prototype uses the Arduino UNO board whose power can be supplied through the USB cable - which can be connected directly to a computer - or external source, being a striking difference between other boards. The Arduino UNO board has 14 pins that can be used as digital input or output. The number of pins on the board allows the entry of the necessary sensors and extra components if required (ARDUINO, 2021).

Besides having a great electronic and financial advantage, as it is affordable to purchase, and easy to program, the plate has small dimensions, and 4 holes, so that it can be fixed to surfaces, which greatly facilitates the location of the plate in silos in which we are presenting.

Considering the project's dimensions and its low cost, the BME280 sensor developed by the German company Bosch was used. The BME280 pressure and relative humidity sensor was made specifically for mobile applications where size and low power consumption are essential requirements (BOSCH SENSORTEC, 2022). In addition to being an affordable sensor, it covers a wide range of temperature (-40ºC to 85ºC), pressure (30,000Pa to 110,000Pa with relative accuracy of 12Pa and absolute accuracy of 100Pa) and relative humidity (0% to 100% RH, with a absolute accuracy of 3% RH). Figure 1 presents the algorithm applied in Arduino.

Figure 1: Schematic of the algorithm's development applied in Arduino.



It was taken into account that the data obtained will be stored on an SD card through the datalogger, defined as data logging where it performs data storage in a location external to the Arduino, which can

be an SD or Micro SD card. It is important to emphasize the possibility of indicating the date and time of such information, if needed. For its operation the SD card module component is necessary, and besides it, the Real Time Clock DS1307 was used to record the date.

The sensors use I2C protocol to communicate data, so it was necessary to use a multiplexer, since the sensors have the same hardware address, causing communication problems between the sensors and the board.

The multiplexer used solved the communication problem, being able to transmit the information collected by the 4 sensors. There will be 4 sensors in total, fixed on affordable bamboo stems, equally spaced and with equally arranged heights.

RESULTS AND DISCUSSION

From the operational point of view, aeration can be defined as the practice of ventilating the grains with scientifically sized air flow, in order to promote the reduction and uniformity of the temperature in the mass of stored grains, aiming a good conservation, by reducing the metabolic activities of the grains themselves and associated organisms (ELIAS et al., 2017).

To achieve these objectives, low airflows are employed, at values close to the convective currents that naturally occur in silos and bulk bins (SILVA, 2011).

As a consequence of the lack of temperature uniformity in the various regions of the mass of grain, air currents are established that circulate from the warmest to the coldest regions. It is worth noting that the internal aeration of the silo is controlled by a fan connected to the silo, which will have its speed regulated by a potentiometer.

The role of the Arduino as a gauge of the silo's internal temperature is of vital importance, because according to Chulze (2010) the relative humidity of the air, and the temperature, are the two variables that most affect the activity of the grains and the organisms that live in bulk.

The results obtained by the sensors, being them temperature, relative humidity, and pressure, were stored in an SD Card, and used for monitoring and observation of the behavior of these variables in the silo prototype. These results will be used for demonstration, study, and development of an ideal condition for grain storage.

Based on the collected data, the user can configure the ideal storage condition for the chosen grain. It is worth mentioning that the configuration of the proposed system is done by the user, not being proposed in an automated way

CONSIDERATIONS

It is concluded that Arduino presents several advantages in the development of prototyping projects, such as simple programming language, low cost and various execution possibilities.

Given the importance of the control of storage systems in the grain production chain, Arduino can be a strong ally in the development of silo projects with low cost, being also available for small farmers who often do not have access to a high value-added technology. In addition, it will assist in monitoring the optimal temperature and relative humidity of the air in an intelligent and precise way.

PRESENTATION: https://youtu.be/aS54BoyVNFo

REFERENCES

ARDUINO. **About Arduino**. Disponível em: . Acesso em: 15 out. 2022.

BOSCH SENSORTEC. **Humidity Sensor BME280**. Disponível em: . Acesso em: 15 out. 2022.

CHULZE, S. N. Strategies to reduce mycotoxin levels in maize during storage: a review. **Food Additives & Contaminants: Part A**, v. 27, n. 5, p. 651–657, maio 2010.

ELIAS, M. C. et al. **Eficiência na aeração de grãos durante a armazenagem**. 2017.

GRUPO DE ROBÓTICA - UFMS. **Introdução ao Arduino**. Fundação Universidade Federal de Mato Grosso do Sul. Faculdade de Computação - FACOM, , 2012. Disponível em: . Acesso em: 15 out. 2022

MCROBERTS, M. **Arduino Básico**. 2. ed. São Paulo: Novatec Editora, 2015.

SILVA, L. C. DA. Aeração de grãos armazenados. **Grãos Brasil: Da Semente ao Consumo**, n. 50, p. 07–10, out. 2011.

SOIL HEALTH ANALYSIS USING PFEIFFER CHROMATOGRAPHY: A CASE STUDY WITH AGROFORESTRY SYSTEMS

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Abstract

Pfeiffer's Circular Chromatography (PCC) is a technique used for the analysis of soil health that is accessible to the farmer because it presents low-cost materials and ease of application, and can be performed and interpreted by the farmer himself. There is also another technique accessible to the farmer, which can improve soil quality and increase productivity, which is the adoption of Agroforestry Systems (AFS). Thus, in order to disseminate alternatives for sustainable and economically productive crops, a demonstration unit of SAF was implemented in the Laboratory of Sustainable Agricultural Practices (LABPAS) of the Fluminense Federal University (UFF). As a way of distinguishing soil characteristics before and after the application of this technique, soil samples were collected and analyzed using PCC. The implantation of a SAF in degraded soil, contributed in a short time to the improvement of its quality, contributing to make it healthier. This evolution was considered through the interpretative comparison of the colors and shapes manifested in the chromatograms. In view of this, it can be concluded that PCC is an efficient method for guiding the small producer in decision-making in the face of the needs of his soil.

Keywords: Agroecology; chromatography; soil fertility

INTRODUCTION

Despite implementing industrial and technological development systems for large-scale agricultural production, conventional management techniques contribute to the degradation of soil, water and natural genetic diversity, leading to a decrease in the productive quality of the soil and the depletion of natural resources. (LICHTFOUSE et al., 2009). Due to this, production capacity is increasingly dependent on chemical packages from conventional agriculture (PRIMAVESI, [s.d.]).

In contrast, agriculture with an ecological focus works on the integration of the principles of the natural system of each place, involving the soil, climate, living beings, as well as the interrelationships between these three components, in order to take advantage of the natural potential of the soil (PRIMAVESI, [s.d.]). Among the agricultural production models based on sustainability, agroforestry systems (AFS) stand out, as they use tree, shrub and herb plants cultivated in consortium with agricultural and forage species, associated or not with animal production (ABDO; VALERI; MARTINS, 2008). SAF's are attractive alternatives for family farmers, rural or urban, as they allow sustainable production from an economic, social and environmental point of view.

In this sense, the knowledge of the quality of the soil gives the producer a direction on how to treat it for the implementation of his cultivar. Pfeiffer's Circular Chromatography (PCC) appears, therefore, as

a low-cost and easy-to-apply technique for soil health analysis. Through the colors, shapes and integrations in the chromatogram, farmers are able to monitor the soil quality of their properties, being able to make more assertive management decision (PINHEIRO, 2015).

According to Pilon (2018); Rivera and Pinheiro (2011), it is necessary to interpret the chromatograms through the isolated zones and the integration between them all. Thus, the central or aeration zone provides information regarding the aeration and oxygenation of the soil. The inner zone presents the mineralogical characteristics of the soil. Meanwhile, the intermediate zone indicates the concentration of organic matter, related to the biological activity of the soil. Finally, the external zone or enzymatic zone, presents aspects of soil vitality and the presence of vitamins, phytohormones among other elements, being revealed through clouds when present in the ideal measure.

MATERIALS AND METHODS

Pfeiffer chromatography was performed in the laboratory of the Graduate Program in Biosystems Engineering (PGEB) of the Fluminense Federal University (UFF) in the city of Niterói, Rio de Janeiro. Soil samples were collected at the Laboratory of Sustainable Agricultural Practices (LABPAS) - Department of Agricultural and Environmental Engineering, on the Praia Vermelha campus. The collected soil is considered landfill and presents civil construction waste, being the site for a long time inactive, mainly due to the Covid-19 pandemic.

The soil was subjected to agroforestry practices during a mini-course "Agroforestry: from teaching to practice" carried out by the UFF extension groups: Propet - sustainability in Veterinary Medicine and MAE - Ecological Agriculture Task Force. During this event, conservation practices were applied to recover the chemical, physical and biological quality of the soil. Agricultural crops, Bokashi fertilizer were used and, as an implementation of organic matter, pieces of banana stem removed from the site were applied. It was therefore decided to collect samples from this plot after two months of agroforestry implementation to compare the soil quality before and after the system.

Based on the methodology of Pilon, Cardoso and Medeiros (2018), 250 g of soil with and without treatment were collected, sieved and placed in the shade for drying. Then, the samples were macerated, sieved in voile, 5 g of each were collected and solubilized with 1% sodium hydroxide (NaOH), performed 7 turns to the right and 7 turns to the left for 15 minutes to rest, repeating the procedure. same turning process and left to rest for 1 hour. After this rest, the last turns were performed, remaining at rest for 6 hours. Subsequently, 150 Whatmann © nº 1 circular filter paper was used for impregnation of silver nitrate (AgNO3) at 0.5%, until the marking of 4 cm from the center of the circular paper, left to rest for 3 hours. wrapped in A4 sheet and paper towel inside a dark box.

After the rest, and decantation of the soil solution was stabilized, 10 mL of supernatant were collected to impregnate the filter paper previously impregnated with AgNO3. Then, paper capillaries were molded and, by capillarity, the solubilized samples infiltrated the paper treated with silver nitrate until reaching the mark of 6 cm from the center of the paper. Finally, the papers were exposed to an airy environment for drying for 14 days.

RESULTS AND DISCUSSION

The soil before the installation of the SAF was evaluated by the PCC and the central zone of the chromatogram was practically non-existent, with irregular size, shape and color. These chromatographic characteristics are common to soils without oxygenation (GRACIANO et al., 2020) and with signs of compaction (SILVA, 2021). In fact, the soil of the evaluated site is the result of a landed area. The inner zone showed a non-homogeneous color, indicating soil with few minerals and no integration of organic matter into the soil (BARROS, 2020). The little accumulation of humus and the low microbiological activity allowed the formation of arrow-shaped radiation in the intermediate zone (RIVERA; PINHEIRO, 2011). In fact, during the plowing of the soil for the implementation of the SAF, it was possible to attest to the almost non-existence of living organisms in the soil. The external zone, also known as the enzymatic zone, showed the intention of forming concentric rings and irregular

coloration, which defines a sample with low enzymatic activity (RIVERA; PINHEIRO, 2011). The zones as a whole did not present integration with each other and their ramifications did not extend through all the zones, presenting a soil with high deficiency (RIVERA; PINHEIRO, 2011).

After two months of SAF implementation, the chromatogram obtained showed significant differences when compared to the chromatogram of the untreated soil (Figure 1).

Figure 1: Untreated soil chromatogram (a). Soil chromatogram with SAF application (b).

(a) (b)

The central zone showed an ideal color and size, indicating a soil without compaction and with adequate aeration (BARROS, 2020). In addition, a high concentration of nitrogen was identified due to the very light central zone, indicating good microbial activity (SIQUEIRA, 2016). There was also an increase in nutrients compared to the previous sample, due to the presence of branches with better quality. However, as it is a soil in the process of recovery, concentric rings and a difficulty in integrating the zones were still found. The intermediate zone showed the best evolution compared to the others, with more standardized ramifications, revealing intense microbiological activity and good quality of organic matter (SILVA, 2021). The external zone, however, remains without quality, with a marked zone, irregular peaks, and without the presence of enzymatic activities.

It is thus noted that the implementation of a SAF in degraded soil, contributed in a short time to the improvement of its quality, contributing to make it healthier. It should also be noted that PCC made it possible to monitor the evolution of the soil, providing important information regarding the increase in ecological terms, in addition to being a simple technique to be performed by a farmer.

CONSIDERATIONS

The results obtained by the Pfeiffer Chromatography indicate that in a short period of time, the implementation of an agroforestry system contributed to transform a compacted soil, with few minerals, low organic matter content and low biological activity into a more aerated soil, with higher of nitrogen, increasing biological activity. Both techniques proved to be technically and ecologically viable to serve the farmer, whether urban or rural.

PRESENTATION: https://youtu.be/EDKc-SH98kY

REFERENCES

ABDO, M.T.V.N.; VALERI, S.V.; MARTINS, A. L. M. Family Farming: A Partnership. **Agricultural Technology & Innovation Magazine**, [s. l.], v. 1, no. 2, p. 50–59, 2008.

BARROS, Carlos Eduardo. **Contributions of pfeiffer's circular chromatography to the analysis of soil health.** 2020. 66 p. Dissertation (Agroecology and Rural Development) - Center for Agrarian Sciences, Federal University of São Carlos, [S. l.], 2020.

GRACIANO, Igor et al. Evaluating Pfeiffer Chromatography for Its Validation as an Indicator of Soil Quality. **Journal of Agricultural Studies**, [s. l.], v. 8, no. 3, p. 420, 2020.

LICHTFOUSE, Eric et al. Agronomy for sustainable agriculture. The review. **Agronomy for Sustainable Development,** [s. l.], v. 29, no. 1, p. 1–6, 2009.

PILON, L.C.; CARDOSO, J.H.; MEDEIROS, F. S. **Pfeiffer's Practical Guide to Chromatography.** [S. l.: n. n.], 2018. Available at: www.embrapa.br/fale-conosco.

PINHEIRO, S.. **Soil Health: Peasant biopower versus agribusiness**. Rio Grande do Sul: Salles Editora, 2015. 224 p.

PRIMAVESI, Ana Maria. **Agricultures-v. 5-No 3-September 2008 Agroecology and soil management**. [S. l.: n. n.], [s. d.].

RIVERA, Jairo Restrepo; PINHEIRO, Sebastian. **Chromatography: images of life and soil destruction.** Colombia, Cali: Feriva Printer, 2011.

SILVA, Marciana Benevides; BEBÉ, Felizarda Viana; SOUZA, Silvas Alvez. **Soil Quality by the Pfeiffer Chromatography Method**. In: FERNANDES, Cinira de Araújo Farias; BABY, Felizarda Viana. **Environmental and Agroecological Studies in Rural Properties**. 1. ed. Curitiba: Editora Appris, 2021. cap. 12, ISBN 9788547336707.

SIQUEIRA, Ivando. **Evaluation of soil fertility and vitality by pfeiffer chromatography and its potential to motivate agroecological management.** 2016. 37 p. Final Paper (Specialization in Peasant Family Agriculture and Rural Education) - Rural Sciences Center, Federal University of Santa Maria, [S. l.], 2016.

THYME CHARACTERISTICS AND APPLICATIONS: A LITERATURE REVIEW

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Abstract

The increase in demand for natural products has motivated the search for plant derivatives as an alternative to synthetic products. In this context, essential oils derived from the genus Thymus, due to their biological activity, have great commercial potential in various industrial applications. Thus, the objective of this study was to conduct a bibliographic review with the genus Thymus in the Scopus and Web of Science databases, especially with the species *Thymus x citriodorus*, between 1991 and 2022, with the purpose of highlighting the distribution of publications during this period, the main countries involved in the research and the purposes of its use. The search for scientific articles was performed using the keywords "*Thymus*" and "*citriodorus*". The publications were separated by year, location, and application in the study of the species *Thymus x citriodorus*. Regarding the analysis of the location, the country where the study was carried out and the origin of the first author of each publication were considered. In the last 10 years, Portugal and Italy stood out in terms of the percentage of contributions. As for the purpose of the study, the characterization of its essential oil, presented greater emphasis.

Keywords: Thymus x citriodorus; biological properties; medicinal plant

INTRODUCTION

Thymus vulgaris, known as common thyme, is a perennial, erect, branched subshrub, approximately 30 cm tall, belonging to the *Lamiaceae* family, with medicinal, aromatic and spice uses, of European origin (Kuete, 2017; Lorenzi and Matos)., 2002).

Thyme has been used in the food industries as a flavouring, flavour enhancer, as well as a food preservative due to its antimicrobial and antioxidant properties. The typical spicy aroma of thyme comes from its essential oil, with thymol, a phenolic monoterpene, its main representative (Stahl-Biskup and Venskutonis, 2012).

The biological composition of this herb has different biological properties making it widely used in traditional medicine due to its antioxidant, antibacterial, antifungal, and antiviral activities. Such properties are used in the treatment of coughs, respiratory infections, gastrointestinal disorders, intestinal infections, urinary tract infections and topical treatment of injuries, among other applications (Nabavi et al., 2015).

Also known as lemon thyme, *Thymus x citriodorus* differs from common thyme in the composition of its essential oil, which is rich in geraniol (Omidbaigi et al., 2005). It is known for its citrus flavour, used mainly for culinary purposes, either as a seasoning or tea (Rita et al., 2018). Essential oils rich in

geraniol have antifungal, antidiabetic, anti-inflammatory, antioxidant, and antitumor activities (Sá et al., 2021).

The increase in demand for natural products has motivated the search for plant derivatives, as an alternative to synthetic products (Ložienė et al., 2021). In this context, essential oils derived from the genus *Thymus*, due to their biological activity, have great commercial potential in various industrial applications.

Thus, the objective of this study was to carry out a bibliographic review with the genus *Thymus* in the Scopus and Web of Science databases, especially with the species *Thymus x citriodorus* referring to the years 1991 and 2022, with the purpose of highlighting the distribution of publications throughout the year. during this period, the main countries involved in the research and the purposes of its use.

MATERIALS AND METHODS

The present study is characterized as a literature review about the genus *Thymus*, focusing on the species *Thymus x citriodorus* (Figure 1). For this, a bibliographic survey was carried out in the Scopus and Web of Science databases. The keywords adopted as search parameters were "*Thymus*" and "*citriodorus*" and the period adopted was from January 1991 to September 2022.

Figure 1: Thymus x citriodorus, also known as lemon thyme.

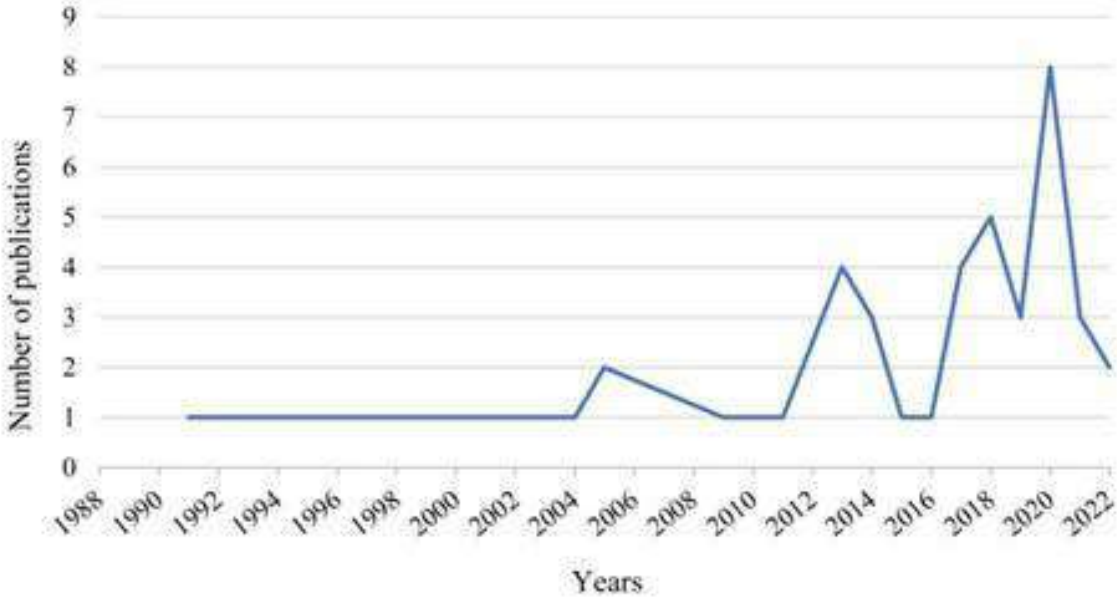
To form a database, the publications (scientific articles) found were separated by year, location, and application in the study of the species *Thymus x citriodorus* using the EXCEL software. For the analysis of the location, the country where the study was carried out and the origin of the first author of each publication were considered.

RESULTS AND DISCUSSION

Regarding the published studies about the *Thymus* genus, it was observed that in the literature, for the last 31 years, only forty-two works were published involving the *Thymus* genus, with emphasis on the last 10 years, with 2020 being the year with the highest number of studies. number of publications

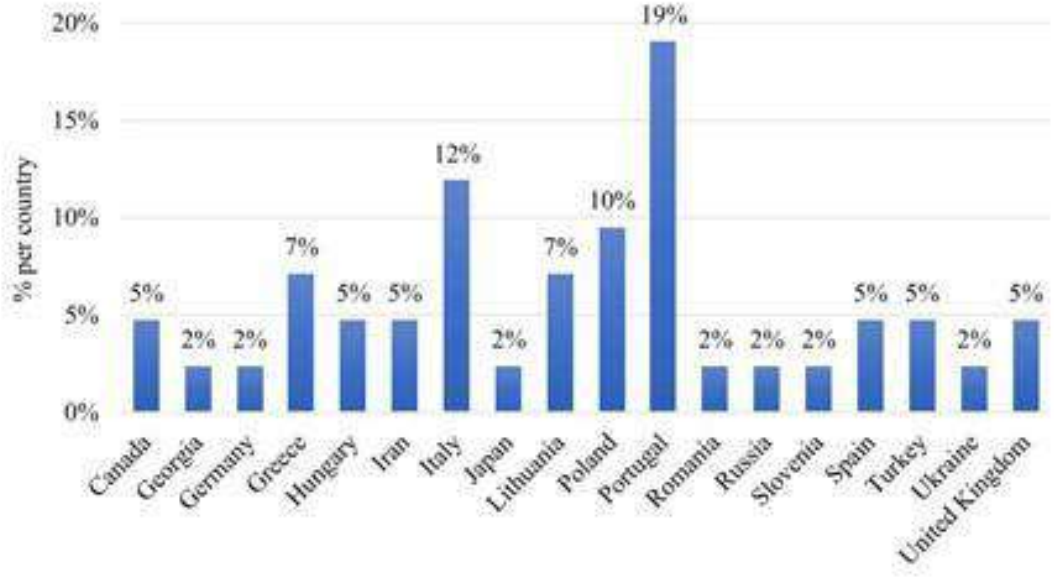
(Figure 2). This demonstrates a greater search for information about gender. Thus, analysing the period from 1991 to 2021, there was an 87.5% increase in published studies on *Thymus* according to the databases analysed.

Figure 2: Number of publications found in the Scopus and Web of Science databases in relation to the genus Thymus in the period 1991 and 2022.



Regarding the distribution of publications of scientific articles by countries, Portugal and Italy stood out, by the percentage of contributions. This analysis also showed a total of eighteen countries with gender surveys (Figure 3).

Figure 3: Countries with the highest percentage of published articles in relation to the species Thymus x citriodorus found in the Scopus and Web of Science databases in relation to the genus Thymus in the period from 1991 to 2022.



For the analysis of the study of the species *Thymus x citriodorus*, from the description of the applications of this species, a table was prepared to better demonstrate these uses, according to the area of application

of each analysed work (Table 1). 26 publications were found with the most diverse approaches. It is observed that 61.5% of the research on this species, most of them seek a better understanding of its biological activities and chemical composition, with emphasis on the characterization of its essential oil, of great commercial interest (Table 1).

Table 1: Main applications found for the species Thymus x citriodorus according to Scopus and Web of Science databases in the period 1991 and 2022.

Aplication	Reports
Influence of edaphoclimatic conditions	Ložienė et al. (2021)
Phytosanitary Properties	Horváth et al. (2004)
Biological Activity	Aprotosoaie et al. (2019); Kodanovi et al. (2020); Taghouti et al. (2020); Sommariva et al. (2020)
Phenolic compounds	Pereira et al. (2013); Raudone et al. (2017); Rita et al. (2018)
Evaluation of morphological and genetic variability	Smolik et al. (2009)
Essential oil composition and chemical characterization	Stahl-Biskup et al. (1995); Svoboda & Grenaway (2003); Omidbaigi et al. (2013); Toncer et al. (2017); Jurevičiūtė et al. (2019); Malankina et al. (2020); Hirai et al. (2022); Oliveira et al. (2022)
Supplementary lighting	Dorais et al. (2018); Dorais et al. (2020)
Different drying techniques	Pasławska et al. (2020)
Effect of substrate type and irrigation frequency	Di Bonito et al. (2018); Papafotiou & Adami (2020)
Biofertilizing and nematicidal properties	Ntalli et al. (2020)
Cultivation	Garibaldi et al. (2016); Bredikhina et al. (2021)

CONSIDERATIONS

Through the bibliographic review, it was observed that studies on the *Thymus* genus are still few, with greater prominence in the last 10 years. A total of eighteen countries generated publications of scientific studies focusing on the *Thymus* genre, with Portugal and Italy being highlighted by the percentage of contributions. Regarding the species *Thymus x citriodorus*, studies were carried out with the most diverse approaches, with greater emphasis on the characterization of its essential oil.

PRESENTATION: https://youtu.be/KUwLSQWl6zc

REFERENCES

KUETE, V. **Medicinal Spices and Vegetables from Africa**, 599–609, 2017.

LORENZI, H.; MATOS, F.J.A. **Plantas medicinais no Brasil; nativas e exóticas cultivadas**. Nova Odessa, SP. Instituto Plantarum, 512 p., 2002.

LOŽIENĖ, K.; VAIČIULYTĖ, V.; MAŽDŽIERIENĖ, R. Influence of meteorological conditions on essential oil composition in geraniol-bearing *Thymus pulegioides* and *Thymus hybrid*. **Acta Physiologiae Plantarum**, 43, 2, 2021.

NABAVI, S. M.; MARCHESE, A.; IZADI, M.; CURTI, V.; DAGLIA, M.; NABAVI, S. F. Plants belonging to the genus *Thymus* as antibacterial agents: From farm to pharmacy. **Food Chemistry**, 173, 339–347, 2015.

OMIDBAIGI, R.; SEFIDKON, F.; HEJAZI, M. Essential oil composition of *Thymus citriodorus L*. cultivated in Iran. **Flavour and Fragrance Journal**, 20(2), 237–238, 2005.

RITA, I.; PEREIRA, C.; BARROS, L.; FERREIRA, I. C. F. R. Exploring reserve lots of *Cymbopogon citratus*, *Aloysia citrodora* and *Thymus* × *citriodorus* as improved sources of phenolic compounds. **Food Chemistry**, 257, 83–89, 2018.

SÁ, R. E.; MONTEIRO, L. D.; SILVA, P. C.; SANTOS, E. S.; VASCONCELOS, V. R. M.; VIEIRA, R. B.; SOUSA, J. D. L.; NASCIMENTO, A. L. L.; CARVALHO, B. L. L.; SILVA, L.F. Geraniol, a component of essential plant oils - a scientific mapping of its pharmacological properties. **Research, Society and Development**, 10, 12, 2021.

STAHL-BISKUP, E.; VENSKUTONIS, R. P. **Handbook of Herbs and Spices**, 499–525, 2012.

TRACEABILITY OF ORGANIC AGRICULTURAL PRODUCTS FOR SMALL PRODUCERS - A REVIEW

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Abstract

Brazil has a strong consumer market for organic products, with a tendency to expand in the coming years. Furthermore, the COVID-19 pandemic will be responsible for the increase in demand in this sector, highlighting the increasing preference of consumers for goods that are aligned with the search for health and well-being, as well as have a guarantee of reliable origin. In this context, the traceability of organic production will play a fundamental role for adequacy and visibility in the market. However, the implementation of a screening system encounters obstacles in the context of small producers and family farmers. Whether due to the high cost of implementation, the lack of familiarity with the proposed technological solutions or the deficiency in management mechanisms, small agricultural producers still need to deal with the lag in relation to this model.

Keywords: Food traceability; Family farming; Small-scaled systems; Environment, Health; Wellness

INTRODUCTION

Small rural landowners and family farmers find in organic agriculture a way to develop socially and economically, adding value to their products and contributing to environmental preservation (PERON et al., 2018). However, to remain competitive and ensure their market share, producers need to adapt to consumer demands.

Recent surveys indicate that consumers are increasingly aware of the food they consume. The recognition of the attributes of sustainability, origin and food safety, aspects very much in vogue in the current context, has the potential to affect the purchase decision of consumers (CUNHA et al., 2011). Moreover, greater transparency in the production and commercialization process, which would provide more information to the final consumer, generates a potential for growth in the national organic market (HOPPE et al., 2013).

Also, considering the scenario due to COVID-19 since 2020, traceability will play a more evident role for organic producers. Sahota (2021) highlights that forecasts point to a rapid growth rate in markets such as Brazil in the coming years. The author also presents transparency and traceability, in addition to changes in consumer behavior, as two of the six ways in which the pandemic is likely to affect the global organic market.

According to Mattos et al. (2009, p. 411): “Tracking is the key in the supply chain approach in the agricultural industry, however, the complexity of its development and its implementation are limiting factors”. Thus, the importance of inserting traceability in the context of production for small producers and family farmers, especially those in the organic products market, becomes evident. The development

of a system that is adequate to the needs of the production units, meets the national legislation, guarantees usability and continuity of use and still meets the requirements of the buyers regarding the consumed product, will guarantee the maintenance of the entire system.

MATERIALS AND METHODS

The present work consists of a narrative literature review built from access to the CAPES Periodicals Portal (Portal de Periódicos CAPES – in Portuguese) and searches directly in the SciELO and Scopus databases.

The following keywords were used: traceability, organic, small producers, family farming and Rio de Janeiro. To refine the searches, the "and" operator was used, creating combinations in pairs and trios of keywords and also using them all in a single search. The objective with the choice of such words and formulation of the combinations was to obtain an overview of the world scenario regarding the traceability of agricultural products, especially organic ones, and then refine the knowledge for the Brazilian reality and also for the state of Rio de Janeiro, in particular for small properties.

Also, to cover the largest possible number of articles, the searches were carried out with the terms in Portuguese and English, obtaining papers in both languages. Among the results found, those that met the criteria: peer-reviewed and open access were selected.

In addition to the databases for obtaining scientific articles, references to laws, international manuals and national normative instructions were also considered in order to provide a greater theoretical basis for research and discussions.

RESULTS AND DISCUSSION

Research shows that Brazil has the largest market for organic products in Latin America. And the demand is growing due to a greater search of the population for health and nutritious food (WILLER et al., 2021). The country is recognized for having a dynamic and highly differentiated organic sector in relation to other Latin American countries, characterized by a robust domestic market, a highly developed value chain and solidary and conscious consumers (FLORES, 2021).

Organic agriculture in the state of Rio de Janeiro developed in the 1980s, making the state a pioneer in this practice. It also fostered the creation of the Associação de Agricultores Biológicos do Estado do Rio de Janeiro (ABIO), which became one of the first certifying agencies in Brazil. The stimulus to organic agriculture in the state was based on environmental awareness, regarding the degradation of soil and water bodies by chemical compounds used in conventional agriculture. Likewise, it soughts to value the production of healthier foods and the creation of value in the work of small producers (BARROS, 2011).

As defined by Codex Alimentarius (2006), traceability is the "ability to follow the movement of a food through specific stages of production, processing and distribution". The big problem to be solved by traceability is to efficiently guarantee access to end-to-end information in the production chain. In this sense, blockchain technology presents itself as a potential solution, as food can be traced back to its origin in real time, generating significant benefits for consumers. Applying this system, agricultural products can be monitored with maximum visibility along the chain (PRASHAR et al., 2020).

Blockchain technology has been studied and incorporated into the context of food production as a very effective solution for monitoring the production chain and implementing traceability systems. Large companies such as Walmart, Nestlé, Subway, in partnership with technology companies such as IBM and SAP, have developed supply chain systems to track their food, including lettuce, tomato, meat, coffee beans, among others, in countries such as the United States, China, France, United Kingdom etc. (XU et al., 2020).

Within a current scenario, with more informed and demanding consumers, the agricultural sector must

prepare to meet market demands. The organization of information and the guarantee of access to the stages of the production chain are important points in obtaining consumer confidence. Therefore, more than ensuring food safety, it is necessary to transmit information about the product that will be consumed (BENEVIDES et al., 2007). However, according to the authors, the documentation of the production stages in the field is precarious, being often carried out in only parts of the production process. More than that, in the reality of small producers and family farmers, such practices become complex activities, since there is little skilled labor to prepare documents, allied to the fact that most producers work alone or with the help of family members, dedicating themselves full-time to production (MUÑOZ et al., 2016).

Furthermore, Benevides et al. (2007) emphasize that, during transport, there is a possibility of information loss, impairing the guarantee of traceability, in addition to the lack of a qualified technical team to perform the records, which makes the reliability of the system unfeasible. Marketing routes can create a struggle in ensuring product traceability. The need to use middlemen to transport production from rural properties becomes a breaking point in the fluidity of the production chain (RABELO et al., 2011).

On the other hand, different studies show that the implementation of a traceability system can have a positive influence on the production stages. In small properties or family producers, implementing traceability can result in increased control over processes and supplies and in greater sanitary control, which can generate an increase in consumer confidence. This greater control can also generate a decrease in production costs, but it can mean an increase in the final cost of the products, due to the costs of implementing the system (PELEGRINO et al., 2020).

Most of the studies focus on the traceability chain from the perspective of the producers or resellers of the products, however the disposition of the final consumers in the process is also a relevant factor in ensuring safety in the food chain. The impacts of not evaluating this aspect can be significant, as well as if the traceability system is considered inefficient (LIN et al., 2021). Current studies indicate that consideration of consumer demands should be a crucial factor in production and sales processes. The agricultural sector can benefit from adapting to a more consumer-centric perspective, including in production and supply chains, since the ultimate objective is to meet the needs and desires of consumers (ANASTASIADIS et al., 2021).

With the organic market expanding, new initiatives gained space for commercialization and promotion of the interface between producers and consumers. Research shows that companies operating as clubs of subscriptions to sell organic baskets work as facilitators in the relationship between producers and consumers. More than that, the use of the internet and other information technologies facilitate the conversion of expert knowledge into everyday language, creating a relationship of trust with customers. The disclosure of “backstage” data and clarity regarding production sites and other information about producers contribute to the perception of security of services (DAVID et al., 2020).

CONSIDERATIONS

The bibliographic review proved to be fundamental to outline the panorama of traceability, enabling the counterpoint between different scales, being them the world scenario, the national state of the art and the reality of small producers and family farmers.

Studies confirm that consumers are increasingly attentive, especially in relation to foods and their origins. Therefore, ensuring the transparency of the supply chain of agricultural products is imperative. More than that, in the niche of organic products, origin tracking is a fundamental part of the relationship between producers and consumers.

The literature translates different initiatives and technologies already used for this purpose, such as blockchain technology. In contrast, the reality of small producers and family farmers is far from such means of implementation. This is because several limitations are documented, such as little specialized labor for operating the systems, low investment potential, rudimentary control of the production chain,

among others.

Thus, all these data provide support for the development of research in the area of traceability of organic products in small rural properties. There is significant reference material on the subject, but it is also possible to list different breaking points for possible local applicability, strengthening proposals for methodologies and implementation.

PRESENTATION: https://youtu.be/skm8fgVNdrc

REFERENCES

ANASTASIADIS, F. et al. Food Traceability: A Consumer-Centric Supply Chain Approach on Sustainable Tomato. **Foods**, v. 10, n. 3, 2021.

BARROS, R. C. Sustentabilidade na Agricultura e Geografia Agrária: O Contexto da Agricultura Orgânica no Rio de Janeiro. **Revista Espaço Aberto**, v.1, n.1, p. 63-87, 2011.

BENEVIDES, S. D.; et. al. Necessidade da Implementação da Rastreabilidade como Ferramenta de Qualidade para a Industrialização da Manga na Zona da Mata Mineira. **Revista Brasileira de Agrociência**, v. 13, n.1, p. 19-24, 2007.

CODEX ALIMENTARIUS. Principles for Traceability/Product Tracing as a Tool within a Food Inspection and Certification System. Food and Agriculture Organization of the United Nations (FAO) e Organização Mundial da Saúde, v.CXG 60-2006, 2006.

CUNHA, C. F.; et. al. Percepção sobre Atributos de Sustentabilidade em um Varejo Supermercadista. **Revista de Administração de Empresas**, v. 51, n. 6, p. 542-552, 2011.

DAVID, M. L.; et. al. Além dos supermercados: novas estratégias no mundo dos alimentos orgânicos no Brasil. **Política & Sociedade**, v. 19, n. 44, 2020.

FLORES, P. Latin America: Na Insight into the Latest Developments In **Organic Agriculture. The World of Organic Agriculture Statistics and Emergin Trends 2021**, v.20210301, p.268-271, 2021.

HOPPE, A.; et. al. Consumer Behaviour Towards Organic Food in Porto Alegre: An Application of the Theory of Planned Behaviour. **Revista de Economia e Sociologia Rural**, v. 51, n.1, p. 69-90, 2013.

LIN, X.; et. al. Consumers' Intention to Adopt Blockchain Food Traceability Technology towards Organic Food Products. **International Journal of Environmental Research and Public Health**, v. 18, n. 3, article 912, 2021.

MATTOS, L. M.; et. Al. Produção Segura e Rastreabilidade de Hortaliças. **Horticultura Brasileira**, v. 27, n. 4, p. 408-413, 2009.

MUÑOZ, C. M. G.; et. al. Normativa de Produção Orgânica no Brasil: a percepção dos agricultores familiares do assentamento da Chapadinha, Sobradinho (DF). **Revista de Economia e Sociologia Rural**, v. 54, n. 02, p. 361-376, 2016.

PELEGRINO, B. O.; et. al. Traceability: Perception and attitudes of artisanal cheese producers in Brazil. **Journal of Dairy Science**, v. 103, n. 5, p. 4874-4879, 2020.

PERON, C. C.; et. al. Produção Orgânica: Uma Estratégia Sustentável e Competitiva para a Agricultura Familiar. **Retratos de Assentamentos**, v. 21, n. 2, p. 104-127, 2018.

PRASHAR, D.; et. al. Blockchain-Based Traceability and Visibility for Agricultural Products: A

Decentralized Way of Ensuring Food Safety in India. **Sustainability**, v. 12, n. 8, article 3497, 2020.

RABELO, F. F.; et. al. A Divulgação Científica como Forma de Disseminação de Conhecimentos sobre Agricultura Orgânica. **Revista Mosaico**, v. 2, n. 2, p. 75-88, 2011.

SAHOTA, A. The Global Market for Organic Food & Drink. **The World of Organic Agriculture Statistics and Emergin Trends 2021**, v.20210301, p.136-139, 2021.

WILLER, H.; et. al. The World of Organic Agriculture Statistics and Emergin Trends 2021. Research Institute of Organic Agriculture FiBL, Frick, **IFOAM – Organics International**. V.20210301, 2021.

XU, J.; et. al. Blockchain: A new safeguard for agri-foods. **Artificial Intelligence in Agriculture**, v.4, p. 153-161, 2020.

USE OF PHOTOSELECTIVE MESHES FOR GROWING ADULT IPECACUANHA: CHANGES IN STEM DIAMETER

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Abstract

Carapichea ipecacuanha is a medicinal plant that produces in its root system, emetine and cephalin, two isoquinolinic alkaloids. The use of photoselective meshes in the cultivation of ipecacuanha is an auxiliary tool in the process of studying the light influence related to the development of this species, to provide results with the desired spectra. Thus, the present work aimed to analyze the diameter of the stem and the number of leaves of the species Carapichea ipecacuanha when grown with different spectral filters by means of photoselective meshes in the colors blue, black and red. The experiment was conducted in the greenhouse with 70% shade on blue, black and red meshes, with five plants per treatment, with four analyses, with a two-week interval between readings. The results showed that only the diameter of the stem was altered when grown on the colored meshes, with the largest diameter evident in the blue mesh and the smallest in the black mesh, but only in the third analysis. The red mesh did not differ from the blue and neither to the black one, in this same period of analysis. Thus, if the plants are kept in this growing environment, with blue mesh, possibly other changes in the growth and development of these plants will be evidenced, as it was for the diameter of the stem.

Keywords: Carapichea ipecacuanha; ipeca; growth; medicinal plants

INTRODUCTION

The cultivation of medicinal plants is a practice adopted since ancient times, because much is known about their importance for the maintenance of human existence due to their benefits (OLIVEIRA &; MARTINS, 1998). However, in order to reach the level of adoption of phytotherapic practices and commercial aspects, it is essential to go through studies of adaptation to the environment in order to obtain the maximum benefit when handling them. To this end, among the medicinal plants cultivated

in artificial environments, it is possible to find Carapichea ipecacuanha (Brot) L. Andersson (Rubiaceae), also known as ipeca-do-brasil, poaia, ipecacuanha or ipeca, which produces in its rhizome and roots, emetine and cephalin, the main existing isoquinolinic alkaloids (DEWICK, 2002).

The use of photoselective meshes in the cultivation of ipecacuanha is an auxiliary tool in the process of studying the light influence related to the development of this species, because light is an energy source for the plant, its presence, as well as intensity and permanence time, will provide different results (GURURURANI et al., 2015; SZYMAŃSKA et al., 2017; DALL'OSTO et al., 2020; DONG et al., 2020).

Therefore, the present work aimed to analyze the stem diameter and the number of leaves of the species Carapichea ipecacuanha when grown with different spectral filters by means of photoselective meshes in blue, black and red colors.

MATERIALS AND METHODS

The experiment was conducted in 70% shaded greenhouse houses with blue, black and red mesh belonging to the Farmácia Viva phytotherapy program at the Universidade Federal Fluminense (UFF), Gragoatá campus in Niterói, Rio de Janeiro, Brazil (22º 54' 00" S; 43º 08' 00" W; altitude 8 meters above sea level). Climatically, the region has an Aw climate, according to the Köppen classification, referring to a tropical climate with dry winters and rainy summers, with a mean annual temperature of 23ºC and mean annual precipitation of 1,200 mm.

The adult plants were being cultivated for a period of 8 years in the 70% shaded environment, in 8 liter pots with sandy soil and irrigation was maintained at field capacity (Figure 1).

Figure 1: Carapichea ipecacuanha plants grown in eight-liter pots

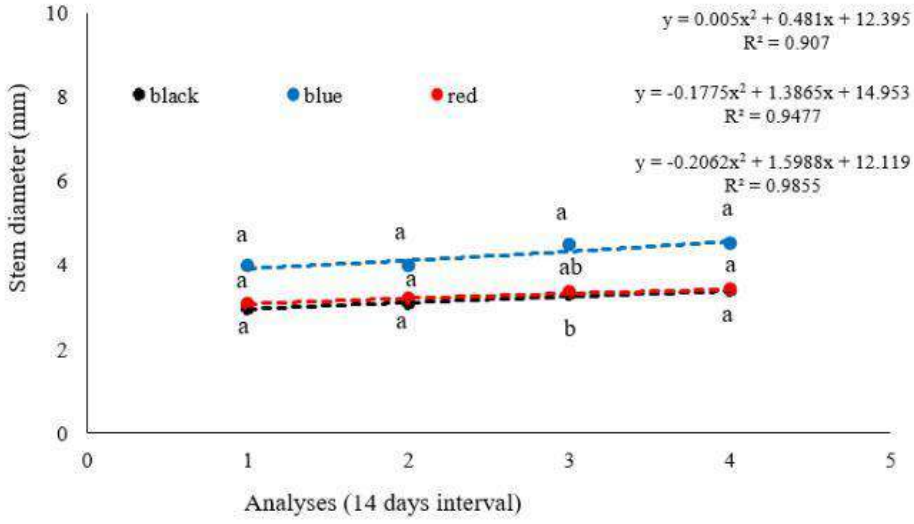
For this, 5 repetitions (plants) were randomly chosen, with one unit per pot in each greenhouse, for growth monitoring, contemplating at the end, four analyses, where the plants were grown in three different greenhouses (blue, red and black mesh). The black mesh was considered as a control, considering the level of shading that is closest to the natural habitat (LAMEIRA, 2002).

The stem diameter assessments were analyzed at 14 day intervals using a digital pachymeter (Stainless Hardened). The analysis started on December 22, 2022 and ended on February 16, 2022, contemplating a total of 4 analyses. The data were submitted to analysis of variance (ANOVA) and the means were compared using Tukey's test at 5%, with n = 4, using the statistical program SISVAR 5.0 (FERREIRA, 2014).

RESULTS AND DISCUSSION

The data of analysis of the parameters of interest of Carapichea ipecacuanha plants in different growing conditions, with photoselective meshes for different colors, were collected and demonstrated in Figure 2, in relation to the diameter of the stem. In the black sombrite, used as a control, blue mesh and red mesh correspond respectively to the black, blue and red lines in the graph.

Figure 2: Diameter of the stem of Carapichea ipecacuanha (ipecacuanha) plants in (mm) with a 14-day interval between analyses.

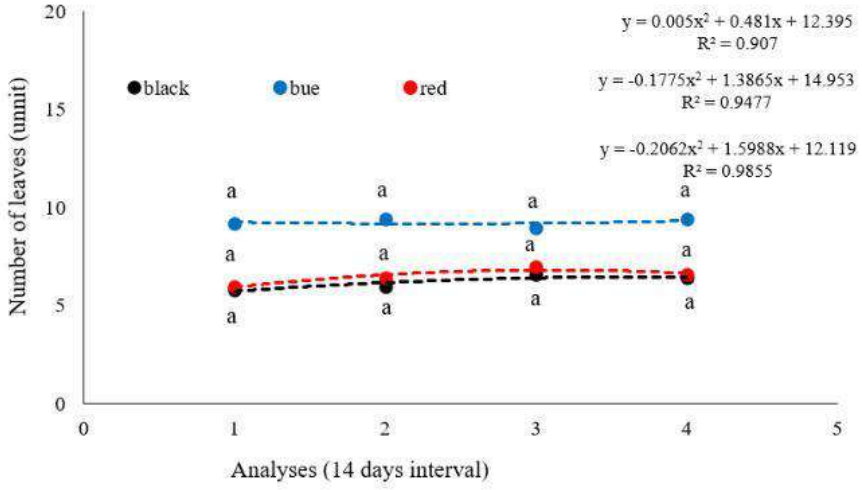


The diameter of the stem was altered when grown in the colored meshes, with the largest diameter being found in the blue mesh and the smallest in the black mesh, but only in the third analysis. The red mesh did not differ from the blue and neither to the black mesh, in this same period of analysis. For the other days, there was no statistical difference (Figure 2).

For the plants when grown in the blue mesh, the average in mm for the diameter of the stem of the plants was 4 mm, while in the black and red mesh it was 3.16 mm and 3.01 mm, respectively.

Data regarding the number of leaves obtained during the experiment were also obtained and are shown in Figure 3. These data show that there was no change over the analyzed days for any of the different forms of growing ipecacuanha, with no statistical difference between the different meshes.

Figure 3: Number of leaves of Carapichea ipecacuanha (ipecacuanha) plants in (units) with a 14-day interval between analyses.



For the plants when grown in the blue shade cloth, they obtained an average leaf count of 9 units and 6.5 units and 5 units for those in black and red shade cloth, respectively.

Thus, the greatest biomass gain was in the blue mesh, but only in the period analyzed for stem diameter. These results show that in summary, both conditions offered by colored shades when compared to black do not provide significant changes, but possibly the permanence of the plants in these environments for a longer period, may provide greater changes.

The observations listed above are in agreement with Ocampo (2007), who states that ipecacuanha is a high-temperature species and, therefore, can be planted in shaded areas for a long period, as long as the average temperature is maintained above 25°C and below 28°C, as occurred in the shaded areas with black shading, where its growth remained stable, especially since the period analyzed was the summer season.

CONSIDERATIONS

The growth monitoring of Carapichea ipecacuanha plants when cultivated in environments containing photoselective meshes with a shading level of 70% showed changes only in relation to the diameter of the stem, in the third analysis, where the plants cultivated in environments containing blue mesh showed greater stem diameter.

PRESENTATION: https://youtu.be/-EEhbtKttQY

REFERENCES

ASSIS, M.; GIULIETTI, A. Diferenciação morfológica e anatômica em populações de “Ipecacuanha” - Psychotria ipecacuanha (Brot.) Stokes (Rubiaceae). **Revista Brasileira de Botânica**, São Paulo, v.22, n.2, p.205-216, ago. 1999.

DALL'OSTO, L. et al. 2020. Complexos monoméricos de captação de luz aumentam a transferência de energia de excitação de LHCII para PSII e controlam seu espaçamento lateral em tilacóides. **Biochimica et Biophysica Acta (BBA)** – Bioenergeticsn 1861, 148035. doi:10.1016/j.bbabio.2019.06.007

DEWICK, PM 2002. **Medicamentos Naturais: Uma Abordagem Biossintética**. 2. ed. John Wiley & Sons, Inglaterra, 515 p.

DONG, Z., et ai. 2020. Aplicação da técnica de imagem de fluorescência da clorofila na análise e detecção de injúria por frio em mudas de tomateiro. **Computadores e Eletrônicos na Agricultura** 168, 105109. https://doi.org/10.1016/j.compag.2019.105109

FERREIRA, DF Sisvar: um guia para seus procedimentos Bootstrap em comparações múltiplas. **Ciência e Agrotecnologia**, v.38, n.2 p. 109-112, 2014. http://dx.doi.org/10.1590/S1413-70542014000200001.

GURURANI, et al. 2015. Regulação da fotossíntese durante a fotoinibição induzida por estresse abiótico. **Planta Molecular** 8, 1304-1320. http://doi:10.1016/j.molp.2015.05.005 LAMEIRA, AL; LEMOS, DE DE; RODRIGUES, IA; ALVES, S. de M.; ROCHA

LAMEIRA, OA; COSTA, MP; PINTO, JEBP; FRANÇA, S. de C.; CONCEIÇÃO, HO da; SANTIAGO, EJA de. Condições de solução- e crescimento de crescimento às plantas de Ipeca e nutritivas em casa. Ciência e Agrotecnologia, v.24, n.1, p.46-53, jan./mar.,2000.

LAMEIRA, OA Cultivo da ipecacuanha [Psychotria ipecacuanha (Brot.) Stokes]. Embrapa: **Circular Técnica, 28:** 1-4, 2002.

NETO, OG da; OLIVEIRA, M. do SP DE; COSTA, MR Ipecacuanha (Psychotria ipecacuanha Stokes). In: EMBRAPA. Centro de Pesquisa Agroflorestal da Amazônia Oriental (Belém, PA). **Programa de melhoramento genético e adaptação de espécies vegetais para a Amazônia Oriental**. Belém: Embrapa Amazônia Oriental, 1999. 137p. (Embrapa Amazônia Oriental. Documentos, 16).

OCAMPO R. 2007. **Ipecacuana Un producto no maderable cultivado bajo el bosque en Costa Rica**. 1980-2000. Disponível em: http://www.allbusiness.com/pharmaceuticals-biotechnology/pharmaceuticals-industry/5493716-1.html Acessado em 12 de janeiro de 2012.

OLIVEIRA, LO; MARTINS, ER **O desafio das plantas medicinais brasileiras: I - o caso da poaia (Ceaphaelis ipecacuanha)**. Campos dos Goytacazes: UENF-FENORTE, 1998. 73p.

RIBEIRO, FNS HÜTHER, CM; MACHADO, TB; LAMEIRA, OA; PEREIRA, CR Propagação de ipecacuanha por estacas de raiz em diferentes condições ambientais e substitutos. Enciclopédia Biosfera, v.14, p.1072-1083, 2017. https://doi.org/10.18677/EnciBio_2017A86

RIBEIRO, FNS HÜTHER, CM; OLIVEIRA, E.; MORAES, JB; MACHADO, TB; LAMEIRA, OA; PEREIRA, CR Influência de diferentes substratos e níveis de influência no crescimento de Carapichea ipecacuanha (ipecacuanha). **Revista Cubana Plantas Medicinales**, v.24, e764, 2019b.

SANTOS, CMPP DOS; HUTHER, CM; BORELLA, J.; RIBEIRO, FNS; DUARTE, GCA; CARVALHO, LF; OLIVEIRA, E.; LAMEIRA, AO; PINHO, CF; MACHADO, TB; PEREIRA, CR A estação e o sombreamento afetam a produção de emetina e cefalina em plantas de Carapichea ipecacuanha. **Plant Biosystems** 1–14, 2020. https://doi.org/10.1080/11263504.2020.1832602

ZAPPI, D; JARDIM, J; SOUZA, EB; DI MAIO, FR; BARBOSA, MR; VALENTE, ASM; SANTOS, LAF; FILHO, NPM Rubiaceae. In: Jakobsson A (ed) **Livro vermelho da flora do Brasil**, 1ª ed. CIP-Brasil, Rio de Janeiro, 922-941, p. 1100, 2013.

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Abstracts Section

ENVIRONMENTAL MANAGEMENT

BIBLIOMETRIC ANALYSIS OF THE RELATIVE SEA LEVEL IN RIO DE JANEIRO STATE

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Abstract

This study tries to bring a bibliometric analysis using VosViewer software to generate quantitative data and bibliometric maps from selected articles from Scopus from 2005 to 2021. We searched inside the Scopus database using the keywords 'Holocene', 'Sea Level', 'Indicator', and 'Rio de Janeiro'. This ongoing research found out that, using the keywords listed, the most cited author who has many published articles is Castro J.W. . In 2014 he published the sea-level curve from Rio de Janeiro and it was widely accepted by the community, and as consequence became the most cited article within the period of study. Furthermore, analyzing selected articles' methodologies revealed that sample pretreatment was made with HCL, this method does not eliminate secondary contaminations. The results shown in this article are halfway as this is an ongoing study and new bibliometric maps will be analyzed.

Keywords: Sea Level, Indicators, Holocene, Rio de Janeiro

INTRODUCTION

Holocene, the current geological epoch, is the most studied epoch within the Quaternary period since its geological evidence is well preserved with nearly 12.000 years old. It is possible to find huge studies related to this epoch, such as palynology, paleoenvironment, and relative sea level variation, etc (BARTH *et al*., 2006; FIGUEIREDO *et al*., 2014; BARRETO *et al*., 2017). Studies on the Holocene may use the sea-level curve to interpret its data relative to paleolevel, therefore research with a focus on building sea-level curves is fundamental to science.

Studies over relative sea-level oscillation - RSLO - supports the understanding of changes in sea amplitude, speed oscillation, and its effects over the coastal zone. Understanding coastal evolution can assist the community in creating actions to prevent and mitigate coastal zone erosion, comprehend the past is essential to build the future. Some authors dedicated themselves to building Brazil's sea-level curves, but one of the first and most important in this research line was Suguio et al. (1985), and from his work arose many other sea-level curves along the Brazilian coast (MARTIN *et al*.; 2003; BEZERRA *et al*.; 2003; ANGULO *et al*., 2006; DIAS *et al.* 2011; CASTRO *et al*., 2014; JESUS *et al*., 2017).

To build the paleolevel we need some RSLO indicators. These indicators can be geological (beachrocks), biological (vermetidae, oyster, corals), or archeological (sambaqui) (SUGUIO *et al*., 1985). The age of these indicators can be obtained through radiocarbon (carbon 14) which detects the age to a maximum of 60.000, approximately, years before the present (ANGULO *et al*., 2004).

This current study aims to analyze which articles and authors are relevant and helped to contribute to the dating of indicators, making a sea-level curve and its methodologies, and applying bibliometric analysis to acquire quantitative data and bibliometric maps. The result shown in this article is halfway and its final version is in development.

MATERIALS AND METHODS

This study tried, from the bibliometric database, to analyze and quantify articles that had the following keywords: 'Holocene', 'Sea Level', 'Indicator', and 'Rio de Janeiro within the period of 2005 to 2021. To analyze and build the bibliometric maps it was necessary to use the software VosViewer, which is a free bibliometric tool that allows creating maps from analysis of citation, cocitation, bibliography coupling, or co-authoring.

To select the articles from these keywords was made a search in the Scopus database and a CSV (comma-separated values) file was downloaded with 46 selected studies. This file was then loaded in VosViewer and therefore made the co-authoring analysis and articles citation aiming to understand which are the authors that were most cited and their published articles along the selected period. The result displayed below consists of a table indicating the main cited authors and their works, and a citation bibliometric map per work.

RESULTS AND DISCUSSION

The sea-level curves are built from the collecting and datings of the indicators. In Rio de Janeiro state numerous of researches were made to re-build the coastal paleoenvironment, paleoproductivity, or the evolution of the coast (BARTH *et al.*, 2006; NAGAI *et al*., 2009; SILVA *et al*., 2014), however, only a few were focus on build the relative sea-level during the Holocene.

Since Suguio, at least five other sea-level curves were built on the Rio de Janeiro coastline, Calheiros (2009), Dias *et al*. (2011), Castro *et al.* (2014), Jesus *et al.* (2017) e Araújo *et al*. (2020). The selected articles demonstrate that Casto is one of the most cited authors and the one with the greatest amount of published works, as seen in Table 1.

The most known Castro work is from 2014, Figure 1, where he proposes a new sea-level curve to the Rio de Janeiro coastline. Since then, being widely accepted by the academic community and commonly used by other authors to interpret their data.

Among the eight authors from Table 1, seven have published works with Castro, except for Bart O.M. This can be interpreted as Castro J.W. being a reference author for the context of this study.

Table 1: Authors' analysis result

Autores	Quantidade de publicação	Quantidade de citação
Castro J.W.	14	137
Cunha A.M.	9	109
Suguio K.	4	98
Seoane J.C.S.	6	76
Dias F.F.	4	69
Barth O.M.	5	41
Tânega F.T.S.	5	41
Areias C.O.	6	39

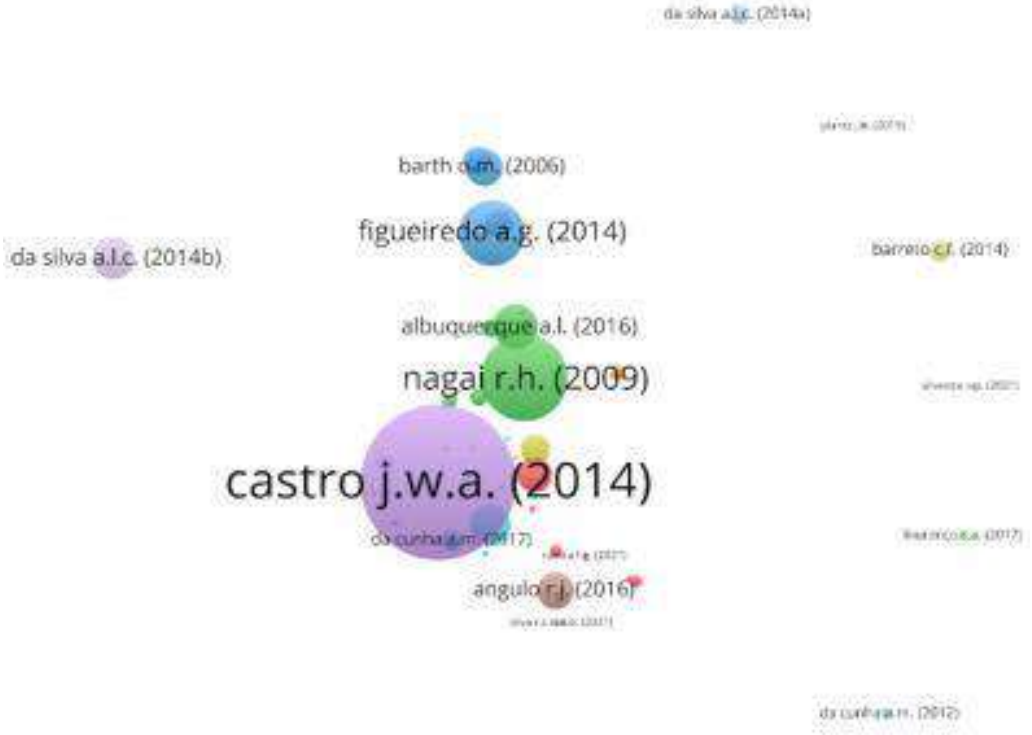
Figure 1 shows the most cited articles accordingly to the size of their circle. Note that Castro *et al.*

(2014), as said early, is the most cited article due to its new version of the sea-level curve for Rio de Janeiro. The next one is Nagai *et al*. (2009) who aimed to identify hydrodynamics regimes and the paleoproductivity related to the relative sea-level oscillation. Followed by Figueiredo *et al*. (2014) that tried to answer questions about the sediment accumulation rate during the Holocene and its relation to RSLO.

The articles mentioned in this work had to carry out dating, and it should come to attention that each article applied a distinct methodology. To carry out datings is imperative to do a pretreatment over the samples, where distinct methodologies are applied, such as washing with HCL and separation of calcite and aragonite to allow the removal of the most recent materials from the samples, resulting in samples close to their real age (MOREIRA *et al*., 2020).

It must be highlighted that many studies were made in Lake Region (Região dos Lagos), in Rio de Janeiro state. This relation can be explained due to the preservation of its indicators, given that urban development may have destroyed coastal indicators in the metropolitan area of Rio de Janeiro.

Figure 1: Citation maps per work



CONSIDERATIONS

The studies here analyzed are extremely important to the academic community, however, these researches must be, somehow, updated. The methodologies applied by the authors in their studies should be reevaluated by using the new pretreatment method (separating calcite and aragonite), which leaves the sample with their age close to real.

Moreover, it is recommended to create a new methodology that patterns from sample collecting to their dating, standardizing the data generated in an open database fully accessible by the academic community.

PRESENTATION: https://youtu.be/JXdGr_9djvg

REFERENCES

ANGULO, R.J. e SOUZA, M. C.(2004) Revisão conceitual de indicadores costeiros de paleoníveis marinhos quaternários no Brasil. **Quaternary and Environmental Geosciences** 05(2):01-32.

ANGULO R.J. et al. (2006). A critical review of Mid- to Late Holocene sea-level fluctuations on the eastern Brazilian coastline. **Quat. Scien. Rev.** 25: 486-506.

ARAUJO, J. et al. (2021). Bioindicators Of Sea-Level Fluctuations In Southeastern Brazil: New Data And Methodological Review. **Radiocarbon**, 63(4).

BARTH, O.M.et al. 2006. Paleoenvironment interpretation of a Paleoenvironment interpretation of a 1760 years B.P. old sediment in a mangrove area of the Bay of Guanabara, using pollen analysis. **Anais da Academia Brasileira de Ciências**, 78: 227-229.

BARRETO, C.F. et al. (2016): A mid-Holocene vegetational and anthropogenic record in the Guanabara Bay region, Rio de Janeiro State, SE Brazil, assessed by palynological and charcoal data, **Grana**, Volume 56, 2017 - Issue 4, DOI: 10.1080/00173134.2016.1238958

BEZERRA, F. H. R. et al. (2003). Holocene sea-level history on the Rio Grande do Norte State coast, **Brazil. Marine Geology** (Print), Holanda, v. 196, n.1-2, p. 73-89.

CASTRO, J.W. et al. (2014). Sea-level fluctuations and coastal evolution in the state of Rio de Janeiro, southeastern Brazil. **An Acad Bras Cienc** 86: 671-683.

CALHEIROS, A.L.S. 2006. **Variações do nível relativo do mar nos últimos 7.000 anos A.P. na planície costeira de Jacarepaguá – Rio de Janeiro: aplicação do programa calib 5.0.1**. Programa de Pós-Graduação em Geologia, Universidade Federal do Rio de Janeiro, Dissertação de mestrado, 110p.

FIGUEIREDO JR. et al. (2014). Linked variations in sediment accumulation rates and sea-level in Guanabara Bay, Brazil, over the last 6000 years. **Paleogeography, Palaeoclimatology, Palaeoecology**. 415. 10.1016/j.palaeo.2014.08.027.

JESUS P.B.et al. (2017). Holocene paleo-sea level in southeastern Brazil: an approach based on vermetids shells**. J. Sediment. Environ**. 2, 35–48.

DIAS, F.F. et al. (2011). Ocorrência de agregados de vermetídeos vivos e fósseis em costões rochosos no Atlântico Sul. In: **Congresso da Associação Brasileira de Estudos do Quaternário – ABEQUA, 13, 2011. Anais**.v.1, p. 202-20

MARTIN, L. et al. 1996. Quais seriam as consequências de uma eventual subida rápida do nível do mar? Considerações a partir da análise de exemplos pretéritos. In: **Congresso brasileiro de geologia** . 34. Anais. Salvador: UFBA, 1996, pp. 275-277.

MARTIN L. 2003. Holocene sea-level history along eastern-southeastern Brazil. **Anuário do Instituto de Geociências/ UFRJ**. 26: 13– 24.

MOREIRA, V. et al. (2020). Aragonite Fraction Dating of Vermetids in the Context of Paleo Sea-Level Curves Reconstruction. **Radiocarbon**, 62(2), 335-348. doi:10.1017/RDC.2020.7

NAGAI, R.H.et al. (2009). Paleoproductivity changes during the Holocene in the inner shelf of Cabo Frio, southeastern Brazilian continental margin: benthic foraminifera and sedimentological proxies. **Quat. Int**. 206, 62–71. https://doi.org/10.1016/j.quaint.2008.10.014

SUGUIO, K. et al. (1985). Flutuações do nível relativo do mar durante o Quaternário superior ao longo do litoral brasileiro e suas implicações na sedimentação costeira. **Rev. Bras. Geo**., 15 (4), 273-286.

CARTOGRAPHY OF ENVIRONMENTAL RACISM: A SURVEY OF SOCIOECONOMIC CHARACTERISTICS IN THE COMPLEXO DE MANGUINHOS - RJ.

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Abstract

The idea of the work was to address the issue of environmental racism, having as stage, the Complexo de Manguinhos. Through literature review, consultations with data from the 2010 Census and cartography, it was possible to show that the predominantly black population and the lack of basic sanitation mark the space.

Keywords: Environmental Justice, vulnerability, Basic sanitation.

INTRODUCTION

The theme Environmental Racism also known in the United States as " Environmental Discrimination", highlights the problems of the environment, the socioeconomic inequalities and policies involving injustices mainly in unsanitary places where people of low purchasing power, unemployed and, for the most part, black, have gained strength in the discussions in some countries of the world mainly in the USA interested in this topic highlighting them with great relevance, because while the economy develops, people are exposed to frequent risks of preventable disease, pollution, piles of garbage and abandoned by the government at the mercy of their own fate (Bullard et al, 2012,).

Throughout history, access to rights associated with the environment has always been guided by social, ethnic and racial inequalities, where this population is exposed to environmental risks, being forced to live in places close to open-air dumps known as dumps, without basic sanitation, lack of potable water and sewage network.

That is caused by the negligence of the government that does not fulfill its role of guaranteeing environmental protection for this group that is marginalized in society. With that, “the The concept of environmental racism has its main focus on racial injustice and evidence of that racialized groups suffer disproportionately from the overall social costs” (LAYS, 2012).

Bringing even closer health promotion in Brazil and on the planet, the assumptions contained in the guidelines mentioned in Funasa's Basic Sanitation Manual, (2015) suggest a narrowing in the way health-related actions are seen and planned, environment, environmental health and epidemiology related to the well-being of any human being who lives in the poorest neighborhoods, where mostly black people live.

Because we know that do not depend only on their own will, but also the context in which they are inserted, whether social, political, economic and cultural (FUNASA, 2015; Bullard et al, 2012).

The present work aimed to bring an approach to environmental racism in the Complexo de Manguinhos, through bibliographic review, search for official data and cartograms about the

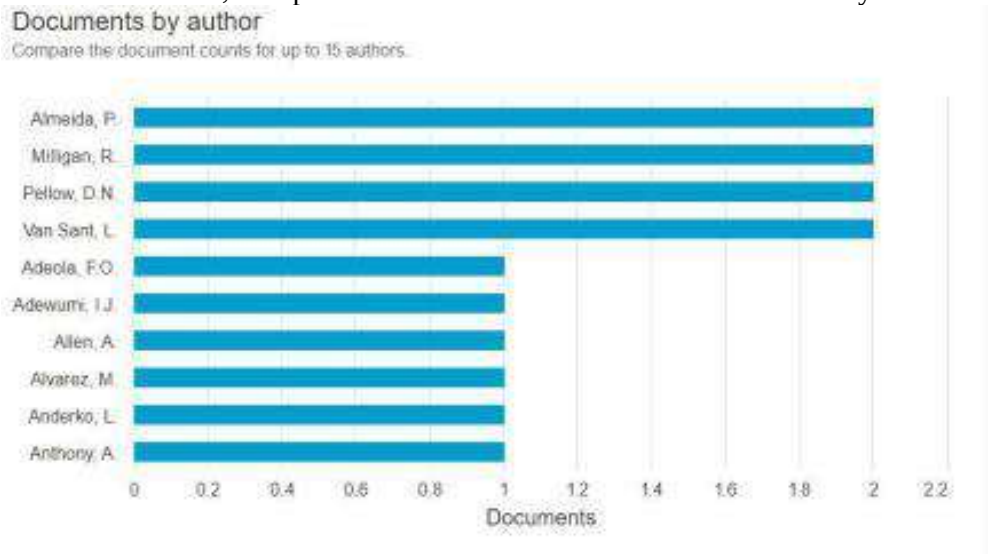
MATERIALS AND METHODS

Through the Capes Portal, it was possible to search the SCOPUS database. In addition to the main authors on "Environmental Racism", the main features of the theme . After this stage, thematic maps of the Manguinhos Complex were built to represent the study.

RESULTS AND DISCUSSION

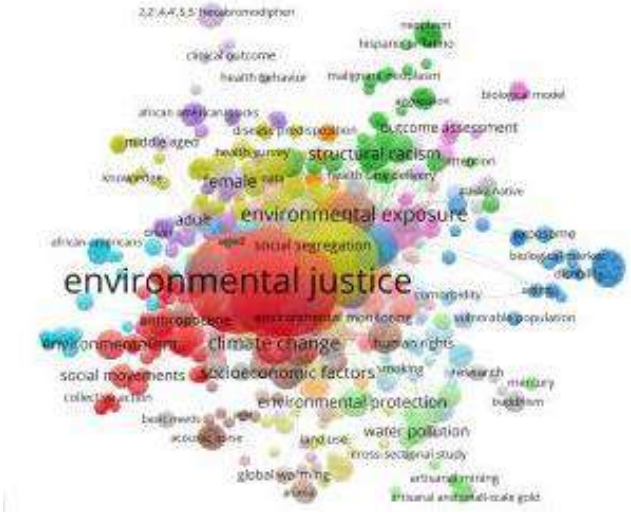
The top 10 that appeared in the search are in the chart below with Almeida, Milligan, and Pellow prominently featured, bringing discussions on the topic of environmental racism (Figure 1).

Figure 1: List of authors who most publish on the subject of environmental racism In possession of the data articles, a map was made in the Vosviewer software of the keywords.



The idea was to find those that would help characterize environmental racism so that, in the next step, some topics with a strong relation to the study could be searched in the census data of the IBGE of 2010. The map of keywords is shown in Figure 2

Figure 2: Keyword map in Vosviewer.



From the various keywords factors found, some were used such as socioeconomic factors, human rights, environmental segregation, health for the generation of thematic maps with data from CENSO 2010. There are several maps being generated but for the purposes o representation in this event the "Basic Sanitation" (Figure 3) and the Ethnic-Racial (Figure 4) maps were used. It is evident that the least favored groups are those represented by blacks, as had already been placed by Bullard et al. (2012) and Lays (2012) with a quality of life quite compromised by the absence of essential services.

The income, although presenting distinct groupings within the complex, show very vulnerable areas, which can compromise food, health care and housing as already commented by Bullard et al. (2012). Similarly, it can be seen that the problems of basic sanitation are very precarious or non-existent, directly impacting the quality of life of people. Herculano (2008) applies, in this case, the concept of Environmental Justice that would be: "set of principles that ensure that no group of people, whether ethnic, racial, or class groups, bear a disproportionate share of the negative environmental consequences of economic operations, federal, state, and local policies and programs, and those resulting from the absence or omission of such policies. " Other analyses can be done such as gender, color, age, diseases related to the inefficiency or inexistence of basic sanitation, among others, also contemplated in the keywords and present in the census data.

Figure 3: Map of basic sanitation in the Complexo de Manguinhos and surrounding areas.

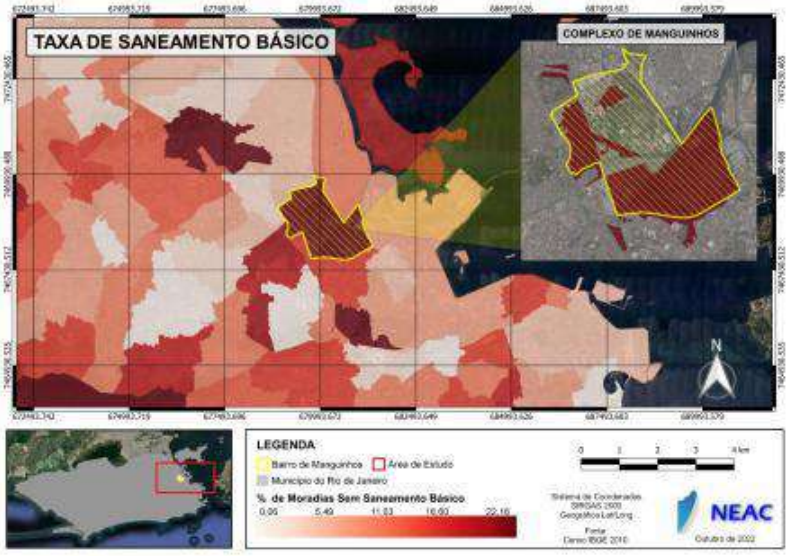
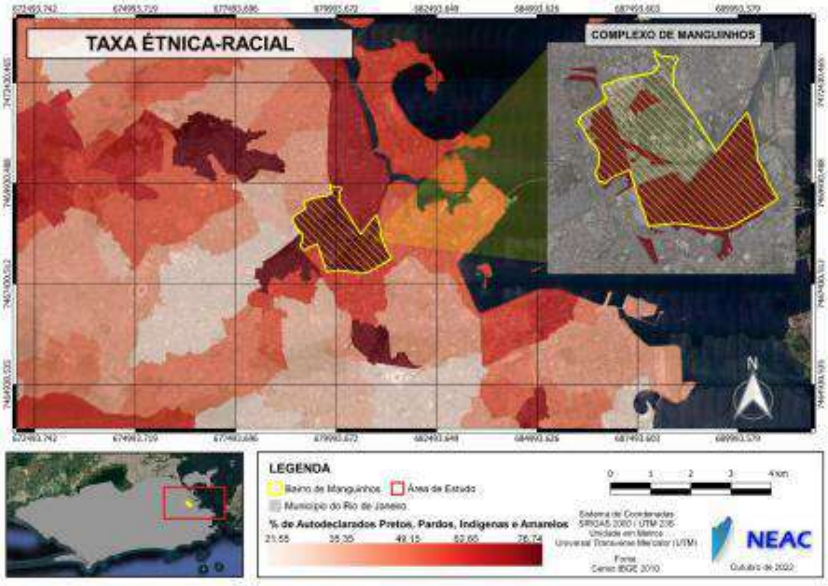


Figure 4: Percentage of Blacks, Browns, Indigenous and Yellows.



CONSIDERATIONS

The theme of environmental racism, unfortunately, brings us back to several problems that should have already been overcome in our society. The Brazilian Constitution of 1988, in art. 225, establishes that everyone has the right to have an ecologically balanced environment, and also states that the public authorities must preserve it for future generations.

The methodology based on updated references obtained from the SCOPUS database allowed a survey of words that are intrinsically linked to the theme in question. These words allowed us to sort the data from IBGE's CENSO 2010 and to cartographically represent some issues that characterize the reality of a community in search of solutions.

PRESENTATION: https://youtu.be/DCmT8fKlEeU

REFERENCES

BULLARD, Robert D.; WRIGHT, Beverly. **The wrong complexion for protection: How the government response to disaster endangers African American communities**. NYU Press, 2012.

IBGE. DEMOGRAPHIC Census 2010: population and household characteristics: universe results. In: IBGE. **Sidra: IBGE system of automatic recovery**. Rio de Janeiro, 2011a. Available at: . Accessed on: mar. 2012.

FUNASA - NATIONAL HEALTH FOUNDATION. **Manual de saneamento**. 4. ed. Brasília, DF, 2015.

HERCULANO, Selene. THE CLAMOR FOR ENVIRONMENTAL JUSTICE AND AGAINST ENVIRONMENTAL RACISM. **Journal of Integrated Management in occupational health and environment**, 3(1), article 2, January/April 2008. Available at: http://www3.sp.senac.br/hotsites/blogs/InterfacEHS/wp-content/uploads/2013/07/art-2-2008-6.pdf . Accessed July 15, 2022.

LAYS HELENA PAES e SILVA. Environment and justice: on the usefulness of the concept of environmental racism in the Brazilian context. **E-cadernos CES** [Online], 17, Sept. 2012. Available at: https://journals.openedition.org/eces/1123#quotation . Accessed on 15 Jul. 2022.

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CHARACTERIZATION OF THE GEOGRAPHIC AND SOCIAL ASPECTS OF COVID-19 CASES AND DEATHS IN ALAGOAS VIA THE GEOGRAPHIC INFORMATION SYSTEM (GIS)

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Abstract

The SARSCoV-2 (COVID-19) pandemic has impacted every country in the world differently. Brazil, with its continental dimensions and accentuated socioeconomic differences between its regions, was one of the most impacted, especially when aspects related to the social vulnerability and lower human development indices (HDI), as is the case of the State of Alagoas. The study consists to characterize the geographic and social aspects of COVID-19 cases and deaths in Alagoas via the Geographic Information System (GIS). COVID-19 case, and death data were obtained from the DATASUS in the period from 03/20220 to 03/2022. The descriptive statistics and exploratory, the climatic mesoregions composed by the East, Hinterland and Arid Alagoano, added to the 10 Health Regions of Alagoas. The study aims to reveal the dynamics of COVID-19 in health regions and in mesoregions of Alagoas, as well as demographic factors, socioeconomic and environmental factors that aggravated the situation of the pandemic in the State. In addition to these, the study aims to demonstrate scientific evidence that support the broad and unrestricted use of the Unified Health System (SUS) as a main institution and bridge between the population impacted by COVID-19 in the Brazil in search of its extensive recovery and post-pandemic care, as well as how to improve the health regions of Alagoas in terms of governance and public administration.

Keywords: SARS-COV-2; Economy; Climate; Health; Social vulnerability.

INTRODUCTION

On March 11, the World Health Organization (WHO) declared the outbreak of coronavirus disease 2019 (COVID-19) caused by respiratory syndrome severe acute coronavirus 2 (SARS-CoV-2), i.e., a pandemic (Cucinotta and Vanelli, 2020; WHO, 2020). Currently, COVID-19 has four different vaccines applied to the Brazilian population: Comirnaty (Pfizer/BioNTech), the Coronavac (Butantan/Sinovac), Covishield (AstraZeneca/Oxford) and Janssen (Johnson & Johnson) – (Sousa et al., 2021; PNOV-COVID-19-MS, 2022).

Furthermore, symptoms caused by COVID-19 are nonspecific or may be absent, posing challenges to

disease control and prevention. like the COVID-19 spreads rapidly, several available data sources have been based on case series or small sections, with limited conclusions (Young et al., 2020; Mizumoto and Chowell, 2020), especially in relationship whether climatic, environmental, and socioeconomic factors aggravated the COVID-19 in the population (Bashir et al., 2020; Bashir et al., 2021).

The current pandemic has highlighted the marked variation in patient demographics, access to health, health infrastructure and preparedness across regions, and these, in turn, had significantly impacted results (Sousa et al. al., 2021). These factors are important for health policy, not only for the current pandemic, but for future global events of endemic outbreaks and new pandemics (Adhikari et al., 2020; Gopinath, 2020; Sanjuan-Reyes et al. al., 2021).

It is important to understand the impact of COVID-19 on the population affected and temporal evolution of the disease in Alagoas, the state with the worst socioeconomic indicators (Oliveira-Júnior et al., 2012; Souza et al., 2021; IBGE, 2022).

This knowledge can help authorities make critical decisions and direct new strategies to improve the Unified Health System (SUS) as the main institution and bridge between the affected population in search of their extensive recovery and post-pandemic care, and how to improve health regions of Alagoas in terms of governance and public management, since that several emerging and neglected diseases have been intensified in the pandemic period.

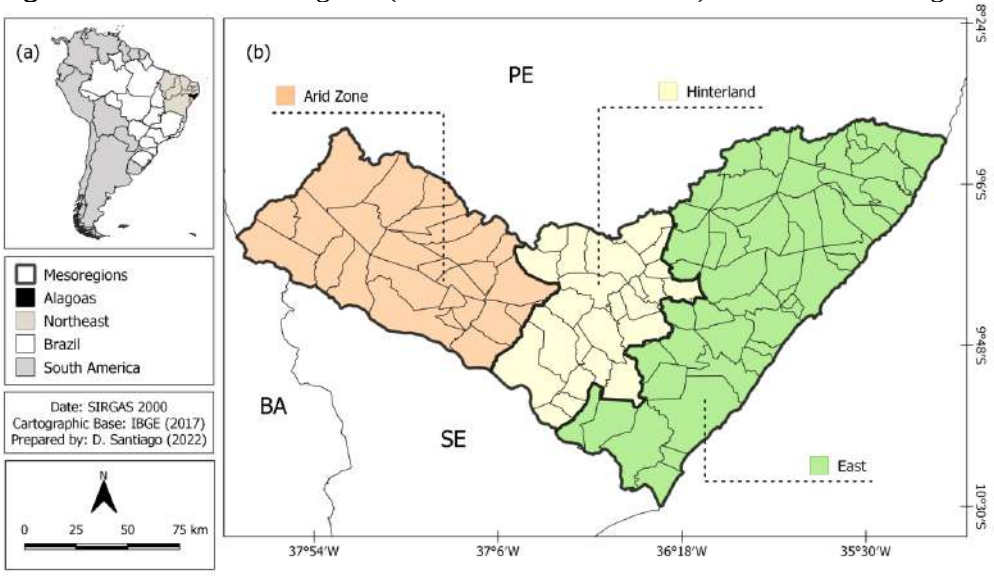
Therefore, the objective is to characterize the geographic and social aspects of COVID-19 cases and deaths in Alagoas via the Geographic Information System (GIS).

MATERIAL AND METHODS

Characterization of the Study Area

The State of Alagoas is located between latitudes 8º48'54" and 10º30'09"S, and the longitudes of 35º09'09" and 38º15'54"W, with altitudes lower than 850 m. Alagoas is one of the 9 in the Northeast region of Brazil (NEB), being the second smallest state in the country with an area of 27,993 km², which corresponds to about of 0.32% of the territory of Brazil. It is limited to the North (N) and West (W) with the State of Pernambuco; to the South (S), with the States of Sergipe and Bahia; The East (E), with the Atlantic Ocean, and, to the Southwest (SW), with the State of Bahia and the São Francisco River (Figure 1). Currently, the state is divided geopolitically in 102 municipalities, with an estimated population of 3,337,357 people (IBGE, 2022) and with three climatic mesoregions: East, Hinterland and Arid Alagoano (Oliveira-Júnior et al., 2012; Souza et al., 2021).

Figure 1: Climatic Mesoregions (Arid, Hinterland and East) of the State of Alagoas.

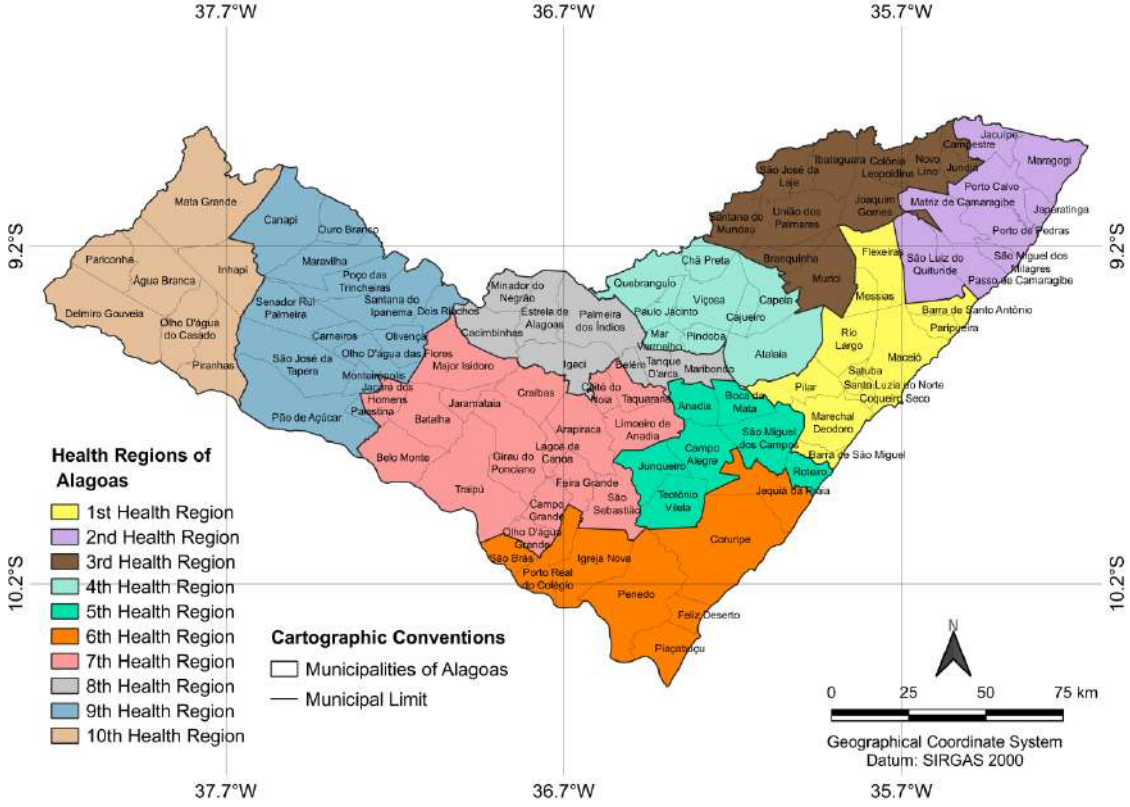


Health Regions of Alagoas

According to the Alagoas Health Regionalization Master Plan (PDR/AL, 2011), Health Region, is a continuous geographic space constituted by groupings of neighboring municipalities, delimited from cultural, economic, and social identities and communication networks and shared transport infrastructure, to integrate the organization, planning and execution of health actions and services. The Health Region must contain, at a minimum, actions, and services for: primary care, urgency and emergency, psychosocial care, outpatient care specialized and hospital care, in addition to health surveillance.

The State of Alagoas is made up of 102 municipalities, distributed in 10 regions. (HR) and organized into two macro-regions that meet the criteria of population density and specialized care technology and hospital.

Figure 2 – Location of the 10 Health Regions of Alagoas. Source: PDR/AL, (2011).



COVID-19 data

Monthly data on COVID-19 cases and deaths from the Department of Informatics of the Unified Health System (DATASUS) in the period from 03/2020 to 03/2022 in the 102 municipalities of Alagoas. The COVID-19 data were on the tabular form and transferred to Excel®. From that, they were organized and made on maps in the Information System Geographical (GIS).

Based on the Quantum GIS software it was established that COVID-19 cases ranged in categories 0-200 to 6400-120000 and obtained between 0-10 to 200-3100. The municipalities that stood out in the spatial analyzes will be evaluated on the time scale in relation to the waves of COVID-19.

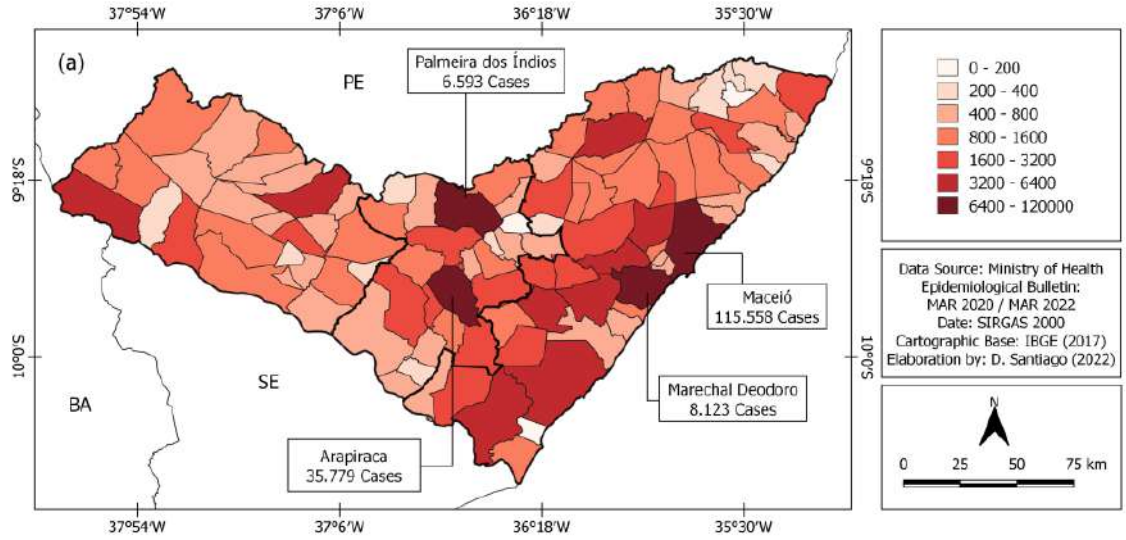
RESULTS AND DISCUSSION

Mapping confirmed cases of COVID-19 in Alagoas in relation to the climatic mesoregions (Figure 3),

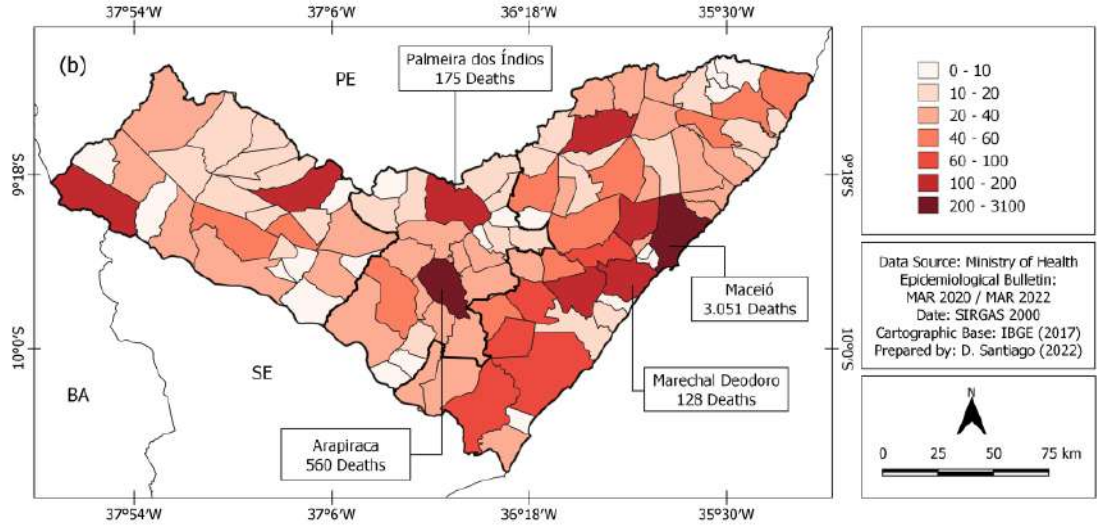
pointed to four municipalities in the category 6400-120000, being Maceió (115,558 cases) and Marechal Deodoro (8,123 cases) belonging to the Metropolitan Region of Maceió (RMM), followed by Arapiraca (35,779 cases) and Palmeira dos Índios (6,593 cases) in the Hinterland region. It is worth mentioning that these municipalities are the most populous in Alagoas, mainly the East Alagoas is the largest region in territorial extension, where most of the population of the State resides (Souza, et. al, 2020; IBGE, 2022).

Figure 3: Distribution of confirmed cases (a) and deaths of COVID-19 (b) in the climatic mesoregions of the State of Alagoas in the period from 03/2020 to 03/2022.

a)



b)

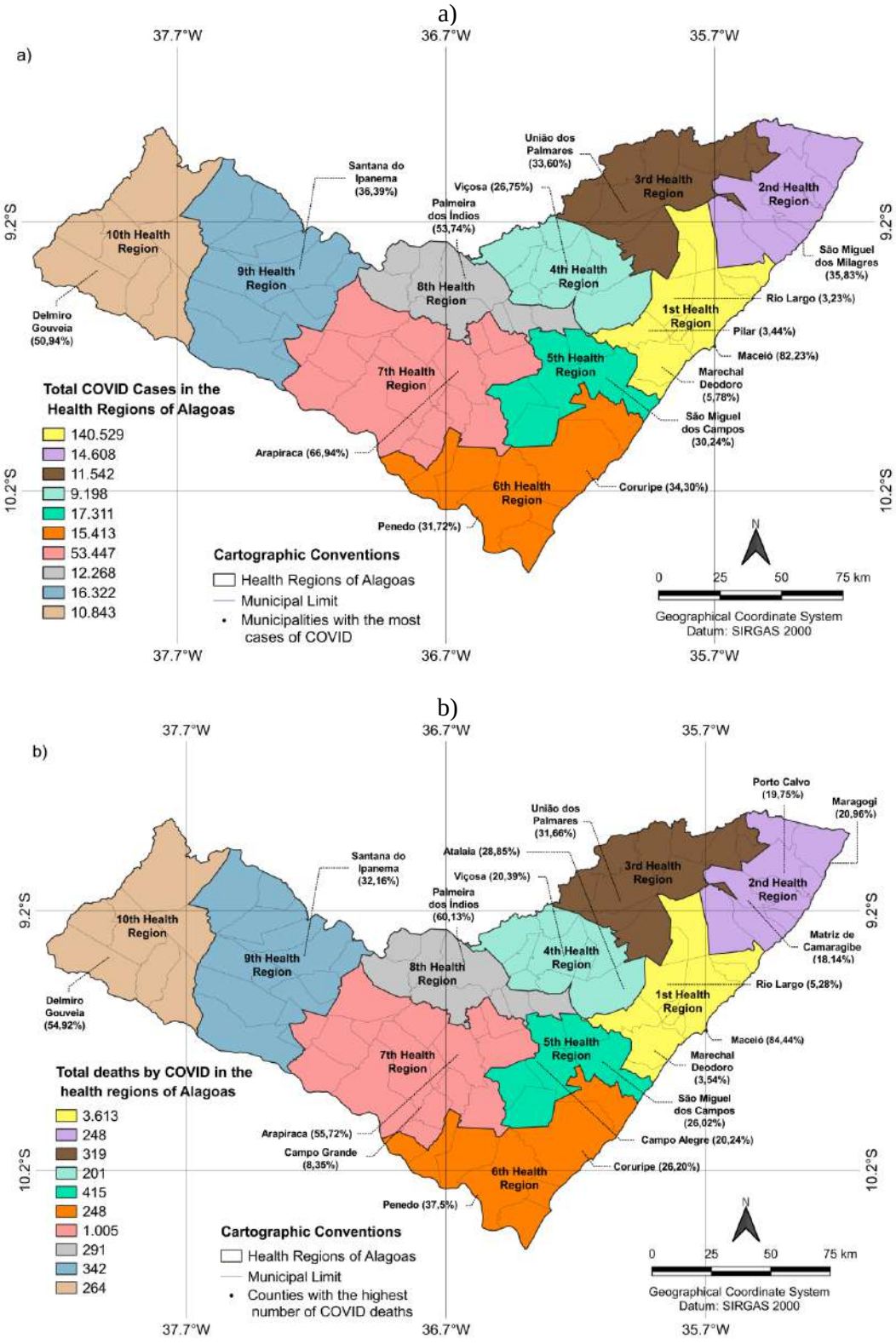


These municipalities were the ones with the highest number of deaths in the state, mainly the most populous municipalities with the highest HDI, in this case, Arapiraca and Maceió. It is worth mentioning that the Arid region mesoregion Alagoas recorded the lowest number of cases and deaths in the study period. Another fact was the category between 0-200 of confirmed cases and deaths occurring, independent of the mesoregion, this may be indicative of underreporting, despite the population size. The number of confirmed cases of COVID- 19 is the most important data for understanding the evolution of this disease (Prado et al., 2020).

Mapping confirmed cases of COVID-19 in health regions in Alagoas (Figure 4), highlighting the 1st

sanitary region with 140,529 cases, mainly in the municipalities of Maceió, Rio Largo, Marechal Deodoro and Pilar all belonging to the RMM, unlike the 10th health region, with the lowest register of confirmed cases of COVID-19. The 7th health region was registered 53,447 cases of COVID-19, this region is on the border between the climatic mesoregions of the State (Figure 1). Analogous to confirmed cases of COVID-19, the cases of deaths were similar in all sanitary regions, except for the 7th region, with emphasis on the municipality of Campo Great.

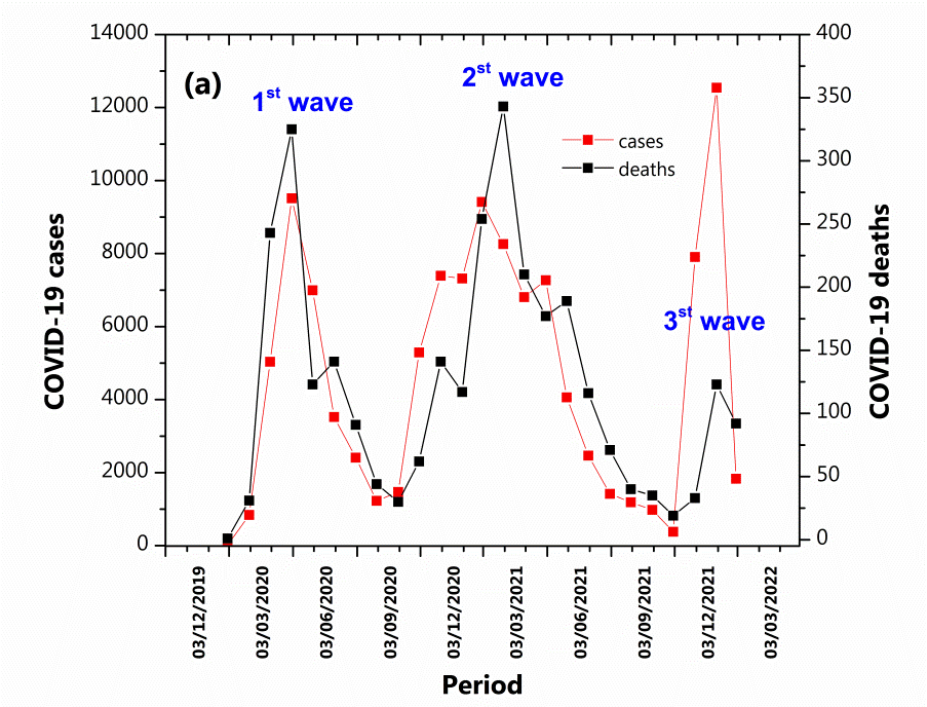
Figure 4: Distribution of confirmed cases (**a**) and deaths in the COVID-19 (**b**) in the Health Regions of Alagoas in the period 03/20220 to 03/2022.



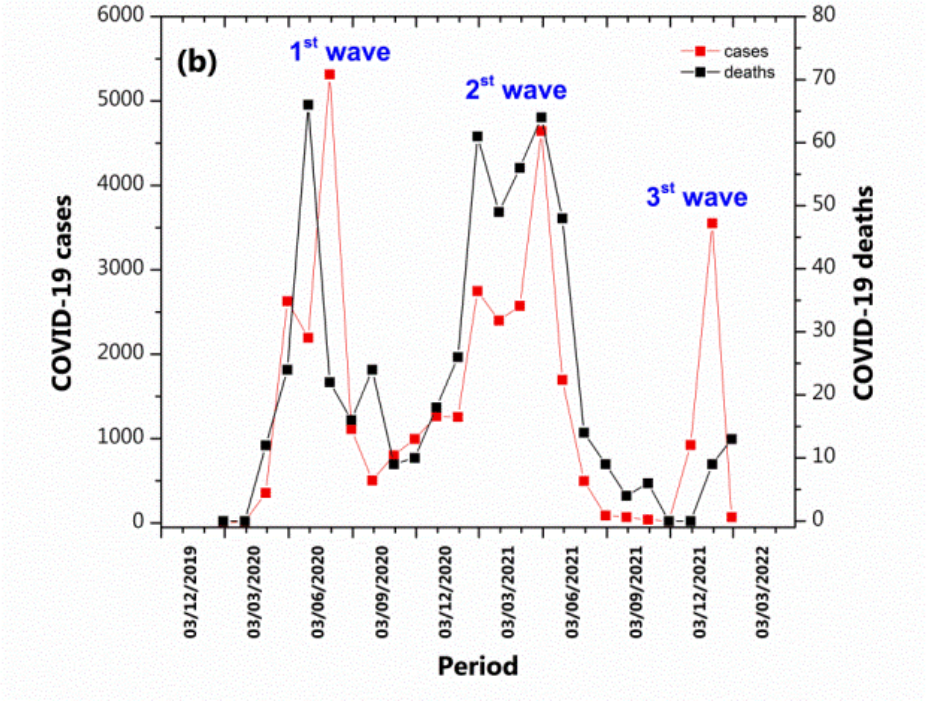
In the temporal evaluation of cases and deaths in the capital of Alagoas (Figure 5a) there were three waves of the pandemic, these waves were reflections of the lockdown actions and, mainly, the action of vaccination in the population in 3rd wave case. In the case of Maceió, the cases of deaths were higher than the cases of COVID-19, on the contrary, in Arapiraca where there was similarity between COVID-19 cases and deaths (Figure 5b). Does not rule out underreporting of cases and deaths, as it brings uncertainties in relation to operational difficulties for carrying out tests on the population (Prado et al., 2020).

Figure 5: Temporal distribution of COVID-19 cases and deaths in municipalities of Maceió (**a**) and Arapiraca (**b**) in the period from 03/20220 to 03/2022.

a)



b)



CONSIDERATIONS

The municipalities that are part of East Alagoas and the 1st Sanitary Region, mainly the municipalities belonging to the RMM stand out in the high registration of cases and deaths of COVID-19, followed by the municipalities of Hinterland and of the 7th Sanitary Region the exception is the Arid and 10th Sanitary Region. In In relation to the most populous municipalities in the State, there are three waves of the pandemic, marked by differences of order of magnitude and action of the lockdown measures and advance vaccination. does not rule out that variability in the number of COVID-19 cases and deaths is due to factors socioeconomic, climatic, and environmental factors and need further in the discussions.

The study will assist in the understanding of SARS-CoV-2, especially in reveal how the dynamics of COVID-19 acted in health regions and in Alagoas mesoregions as well as demographic factors, socioeconomic and environmental factors aggravated the situation of the pandemic in the state. This study seeks to demonstrate the scientific evidence that supports the use broad and unrestricted use of the Unified Health System (SUS) as the main institution and bridge between the population impacted by COVID-19 in Brazil in search of their broad recovery and post-pandemic care, as well as improving regions of health in Alagoas in terms of governance and public management.

PRESENTATION: https://youtu.be/U2ruQREXwWM

REFERENCES

ADHIKARI, S.P., MENG, S., WU, Y.-J., MAO, Y.-P., YE, R.-X., WANG, Q.-Z., SUN, C., SYLVIA, S., ROZELLE, S., RAAT, H., ZHOU, H., 2020. Epidemiology, causes, clinical manifestationand diagnosis, prevention, and control of coronavirus disease (COVID-19) during the early outbreak period: a scoping review. **Infectious Diseases of Poverty** 9, 29.

BASHIR, M. F., MA, B., KOMAL, B., BASHIR, M. A., TAN, D., BASHIR, M. Correlation between climate indicators and COVID-19 pandemic in New York, USA. **Science of The Total Environment**, v. 728, p. 138835, 2020.

BASHIR, M. F., SHAHZAD, K., KOMAL, B., BASHIR, M. A., BASHIR, M., TAN, D., NUMAN, U. Environmental quality, climate indicators, and COVID-19 pandemic: insights from top 10 most affected states of the USA. **Environmental Science and Pollution Research**, v. 28, n. 25, p. 32856- 32865, 2021.

CUCINOTTA, D.; VANELLI, M. WHO declares COVID-19 a pandemic. **Acta biomedica: Atenei Parmensis**, v. 91, p. 157-60, 2020.

GOPINATH, G. 2020. **The Great Lockdown: Worst Economic Downturn Since the Great Depression**. https://blogs.imf.org/2020/04/14/the-great-lockdown-worst-economicdownturn-since-the-great-depression/.

IBGE - Instituto Brasileiro de Geografia e Estatística. **Censo Brasileiro de 2020**. Alagoas: IBGE, 2022.

MIZUMOTO, K.; CHOWELL, G. Estimating risk for death from 2019 novel coronavirus disease, China, January-February 2020. **Emerging Infect Diseases**, v. 26, p.1226-1256, 2020.

OLIVEIRA JÚNIOR, J. F.; LYRA, G. B.; GOIS, G.; BRITO, T.T.; MOURA, N. S. H. Análise de homogeneidade de séries pluviométricas para determinação do índice de seca IPP no estado de Alagoas. **Floresta e Ambiente**, v. 19, p. 101-112, 2012.

Alagoas. **Plano Diretor de Regionalização da Saúde do Estado de Alagoas - PDR/AL** - Revisão no Ano 2011. Disponível em: pdr_2011.pdf (saude.al.gov.br). Acessado em 21/05/2022.

Brasil. **Plano Nacional de Operacionalização da Vacinação Contra a COVID-19-MS**, 12ª edição. Disponível em: https://www.gov.br/saude/pt-br/coronavirus/publicacoes-tecnicas/guias-e-planos/plano-nacional-de-operacionalizacao-da-vacinacao-contra-covid-19.pdf/view. Acessado em: 21/05/2022.

PRADO, M. F. D., ANTUNES, B. B. D. P., BASTOS, L. D. S. L., PERES, I. T., SILVA, A. D. A. B. D., DANTAS, L. F., ... ; BOZZA, F. A. (2020). Análise da subnotificação de COVID-19 no Brasil**. Revista Brasileira de Terapia Intensiva**, 32, 224-228.

SANJUAN-REYES, S., GÓMEZ-OLIVÁN, L. M.; ISLAS-FLORES, H. (2021). COVID-19 in the environment. **Chemosphere**, 263, 127973.

SOUSA, A., ABREU, M. C., OLIVEIRA-JÚNIOR, J. F., FERNANDES, W. A., SOUZA, D. M., SILVA, S. D., SANTOS, C. M., SILVA, E. B. (2021). Generalized models and the impacts of population density on COVID-19 transmission. **Journal Health NPEPS**, 6, 1-23.

SOUZA, E. O., COSTA, M. S., OLIVEIRA JÚNIOR, J. F., GOIS, G.; MARIANO, G. L., COSTA, C. E. S., CORREIA FILHO, W. L. F., SANTIAGO, D. B. Estimativa e Espacialização da Erosividade em Mesorregiões Climáticas no Estado de Alagoas. **Revista Brasileira de Meteorologia**, v. 35 (spe), p. 769-783, 2021.

World Health Organization. (2020). **Coronavirus disease (COVID-2019) situation reports**. Geneva: World Health Organization. Retrieved March 23, 2020, from https://www.who.int/emergencies/diseases/novel-coronavirus-2019/situation-reports/

YOUNG, B.E.; ONG, S.W.X.; KALIMUDDIN, S. Epidemiologic features and clinical course of patients infected with SARS-CoV-2 in Singapore. **JAMA**, v. 323, n. 15, p. 1488-1494, 2020.