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PHYSICOCHEMICAL ANALYSIS OF A GONGOCOMPOSITE IN THE INITIAL PRODUCTION OF CRISP LETTUCE SEEDLINGS

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ABSTRACT - Tree pruning in urban centers generates residues, which can be used as organic composites in the production of crisp lettuce seedlings. Given the above, the aim of this work was to perform a physicochemical analysis of the gongocomposite in the production of crisp lettuce seedlings. The experiment was carried out in a rural property in *Reserva do Cabaçal*-MT, with a completely randomized design comprising five treatments and five replications. To obtain the substrates, the gongocomposite was made from *Trigoniulus corallinus,* in the following proportions: 40% of *Paspalum notatum* (grass) + 30% of the pruning residues of tree species *Terminalia catappa*, *Licania tomentosa*, *Senna siamea*, and *Albizia lebbeck* composed of leaves, leaflets, and fine branches, dried and crushed, where the process lasted 120 days. Substrates were evaluated regarding physical and chemical properties. At 24 days after sowing, shoot fresh and dry mass, root fresh and dry mass, root volume, seedling vigor, and stability of lettuce clods were measured. The gongocomposite from the grass (*Paspalum notatum*) + oiti + albizia (40% + 30% pruning residues + 30% pruning residues) presented better physicochemical characteristics and better initial development of lettuce seedlings.
Keywords: *Lactuca sativa* L., organic substrate, pH, nutrients, agronomic characteristics.

ANÁLISE FÍSICO-QUÍMICA DO GONGOCOMPOSTO NA PRODUÇÃO INICIAL DE MUDAS DE ALFACE CRESPA

RESUMO - As podas arbóreas nos centros urbanos geram resíduos, que podem ser aproveitados como composto orgânico na produção de mudas de alface tipo crespa. Diante do exposto, objetivou-se com o presente trabalho realizar uma análise físico-química do gongocomposto na produção de mudas de alface tipo crespa. O experimento foi realizado em uma propriedade rural de Reserva do Cabaçal-MT, com delineamento inteiramente casualizado, contendo cinco tratamentos e cinco repetições. Para obtenção dos substratos o gongocomposto foi feito a partir do *Trigoniulus corallinus*, nas seguintes proporções: 40% de aparas de *Paspalum notatum* (grama) + 30% de dos resíduos de podas das espécies arbóreas: *Terminalia catappa*, *Licania tomentosa*, *Senna siamea*, *Albizia lebbeck* composta por folhas, folíolos e galhos finos, secos e triturados, onde o processo durou 120 dias. Os substratos foram avaliados quanto às propriedades físicas e químicas. Aos 24 dias após a semeadura, foram realizadas a massa fresca e seca da parte aérea, massa fresca e seca de raízes, volume de raízes, o vigor da muda e estabilidade dos torrões de alface.O gongocomposto elaborado a partir da mistura de grama (*Paspalum notatum*) + oiti + albizia (40% + 30% de resíduos de poda + 30% de resíduos de poda) apresentou melhores características físico-químicas e melhor desenvolvimento inicial de mudas de alface.
Palavras-chave: *Lactuca sativa* L., substrato orgânico, pH, nutrientes, características agronômicas.

INTRODUCTION

Lettuce (*Lactuca sativa* L.) is a leaf vegetable widely planted and consumed in Brazil, especially considering the new feeding habits based on more balanced and natural diets, and vitamin and minerals sources. It is a very delicate leafy plant, with unbranched and reduced stem to which the leaves connect to. Lettuce colors vary from yellowish green to dark green, with some cultivars presenting purple edges. Their roots are taproots, up to 60 cm deep (FILGUEIRA, 2013). Currently, the most important lettuce for economy is the "crisp" group, being preferred by 70% of the Brazilian market, followed by the iceberg (15%), butterhead (10%), and romaine (5%) kinds (QUEIROZ et al., 2017).

One of the limiting factors to raise lettuce seedlings is the production of good quality substrates, with increased biodiversity of the composite, resulting in the appearance of microorganisms that favor the plant growth, enhancing long-term productivity (FINATTO et al., 2013).

Some waste from urban pruning can be used to improve compounds biodiversity, such as the almond tree (*Terminalia catappa*), the *oitizeiro* (*Licania tomentosa*), Siamese cassia (*Senna siamea*), and lebbek tree (*Albizia lebbeck*), which show a surplus of nutrients like nitrogen, phosphorus, and potassium seasonably, slowly released into

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the soil or substrate via an activity carried out by microorganisms (SUZEK et al., 2021). These microorganisms mineralize the organic part of the tree culture waste, turning it into fertilizer, making nutrients available especially during the initial phase of seedlings and during the whole growth cycle, yielding low cost for producers. Hence, the production of lettuce is made viable, also highlighting the importance of the development of technologies that enable the production of substrates from easily producible materials, such as the reuse of waste from pruning of urban tree species (SOUZA et al., 2013).

A subject that remains little explored regarding waste is the high volume of leaves, branches, tree trunks, and remaining components coming from urban trees, which are discarded, produced by daily pruning in public areas (SUSZEK et al., 2021). However, to reduce the amount of urban waste from different species of trees, the technique for grouping such material with the detritivore macrofauna was adapted, which is responsible for enhancing the decomposition of this organic waste via their feeding activity. This technique is still little known in Brazil and is named “gongodecomposition”. The millipedes fragment the vegetable matter, making stable organic matter with adequate physicochemical properties available in their excrements (coprolites), yielding the millipede fertilizer (gongocomposite), which can be used as substrate for seedling production (ANTUNES et al., 2016).

Studies were carried out with the *Trigoniulus corallinus* species - popularly known in Brazil as *gongolos*, *piolhos-de-cobra*, or *grangugis* - on lettuce seedlings using organic waste on the gongodecomposition process, such as Brazilian orchid tree leaves, chopped grass, Musa leaves, and carton (ANTUNES et al., 2018). The same authors verified that such waste is considered to yield high-quality composites that provide excellent seedling development and high agronomic performance in production fields. However, research on the handling and transformation of organic waste via gongodecomposition must advance, since there are no adequate results available in Brazil.

Given the aforementioned, the current work had the objective of evaluating the efficiency of the gongocomposite from organic waste obtained from the pruning of different tree species on the production of lettuce seedlings.

MATERIALS AND METHODS

The experiment was carried out in a rural property in the city of *Reserva do Cabaçal* (*Mato Grosso* state) and the analyses were made at the Mato Grosso State University (*Universidade Estadual de Mato Grosso - UNEMAT*), *Cáceres* (*Mato Grosso* state). The climate in the region according to Köppen is categorized as *Aw*, hot and wet, with rainfall concentrated in the period from November to March and average annual precipitation of 1213mm (ALVARES et al., 2013).

The millipedes of the *Trigoniulus corallinus* species were collected at the city of *Reserva do Cabaçal*, Mato Grosso state, normalized by size and deployed on the substrate surface to enable its natural penetration in the soil.

The tree species used in the experiment were chosen according to the number of trees in a tally ran in 2019 by the Urban Cleaning Company of *Reserva do Cabaçal* (*Companhia Municipal de Limpeza Urbana da Cidade de Reserva do Cabaçal* - COMLURB), owned by the city hall, which identified the almond tree (*Terminalia catappa*), the *oitizeiro* (*Licania tomentosa*), the Siamese cassia (*Senna siamea*), and the lebbek tree (*Albizia lebbeck*). The pruning waste from the tree species for gongodecomposition was collected in the city of *Reserva do Cabaçal* (*Mato Grosso* state).

To obtain the substrates from the gongodecomposition process, the following ratios were followed: 40% chopped grass (*Paspalum notatum*) + 30% pruning waste from each tree species comprised of leaves, leflets, and fine branches (naturally dried from 15 to 20 days and crushed in a continuous knife mill). Next, the mixture was deployed into 20 concrete rings (40 L) with 50 centimeters and 0.3 L of *gongolos* were placed into each of the rings. The gongodecomposition process lasted 120 days - it started in May of 2020 and ended in September of the same year. The matter formed was taken from the rings, sieved in 2 mm meshes, and taken to physicochemical analysis. To characterize the gongocomposites and the Plantmax® substrate, tripled analyses were carried out to determine the pH in a distilled water solution (5:1 v/v) and to determine the electrical conductivity in the same aqueous extract from the pH measurement, according to the method described by the Brazilian Agriculture Ministry (*Ministério da Agricultura*) (MAPA, 2017).

The determination of the carbon to nitrogen ratio (C:N) was carried out in an elemental analyzer (CHN), also known as the Dumas method. Next, the amounts of nitrogen (N), carbon (C), phosphorus (P), potassium (K), calcium (Ca), and magnesium (Mg) were determined according to the methodology described by Embrapa (SANTOS et al., 2018). The volumetric mass density, micro and macroporosity, the total porosity, and the water retaining capacity of the substrates were determined according to the methodology adapted in the Normative Instruction (*Instrução Normativa* - IN) (IN n.17) by the Brazilian Agriculture Ministry (*Ministério da Agricultura*) (MAPA, 2017). The materials used for the analyzes were 15 aluminum cylinders (three-fold), with 100 cm^3 of capacity, which were filled with the substrates to their maximum capacity and sealed (with nonwoven fabric and rubber band) on their bottom opening. The cylinders were saturated with water, kept for drying, with their bottom end in contact with a sheet of blotting paper (with pores ≤0.0025 cm or 2.5 µ).

To evaluate the efficiency of the gongocomposites on the production of lettuce (*Lactuca sativa* L.) seedlings, the following treatments were applied: T1 = AM + CA (40% grass (*Paspalum notatum*) + 30% almond tree pruning waste + 30% Siamese cassia pruning waste), T2 = AM + AL (40% grass (*Paspalum notatum*) + 30% almond tree pruning waste + 30% lebbek tree pruning waste), T3 = OI + CA (40% grass (*Paspalum notatum*) + 30% *oitizeiro* pruning waste + 30% Siamese cassia pruning waste), T4 = OI + AL (40% grass (*Paspalum notatum*) + 30% *oitizeiro* pruning waste + 30% lebbek tree pruning waste) and T5 = Plantmax® substrate (witness).

For the seeding of the crisp lettuce (Hortifruti®) several polystyrene trays expanded with 200 cells were used, adding three pelletized seeds per crisp lettuce cell. At four days after seeding (DAS), the trays were jointed, keeping only one seedling per cell. At 24 DAS, ten lettuce seedlings were taken at random per experimental unit for the evaluation of the shoot and root wet biomass. The aerial part and the root of the plants were weighted in an analytical balance (with four decimal digits and results given in mg) and dried in a greenhouse at 65°C for 72 h, deployed in sack kraft paper. Afterwards, they were weighted using a *Marte* branded analytical balance (with four decimal digits and results given in mg). The root volume (cm^3) was determined by the difference of the water column measured in a glass graduated cylinder.

The seedlings vigor was determined according with the methodology adapted from Franzin et al. (2005), with scores ranging from 1 to 4, where: score 1 = great vigor, 5+ leaves, height > 5 cm; score 2 = good vigor, 4 to 5 leaves, height > 5 cm, with no visible yellow areas; score 3 = visible yellow areas, 4 to 5 leaves, height up to 5 cm, with detectable nutritional deficit; score 4 = nutritional deficit, height < 5 cm, less than 4 leaves.

The stability of clod was determined according to the methodology adapted from Gruszynski (2002), with scores ranging from 1 to 4, where: score 1 = 50% or more of the clod stays in the container when removing the seedling; score 2 = 30 to 50% of the clod stays in the container when removing the seedling; score 3 = clod completely leaves the container, but crumbles; score 4 = clod completely leaves the container and more than 90% does not crumble.

The experimental design used was completely random, comprising five treatments and five repetitions. For the data analysis, the homogeneity of the error variances was evaluated via the Bartlett's Test and their normality, via the Shapiro-Wilk Test. The data variance was analyzed via the Scott-Knott test ($p \leq 0.05$) by using the Sisvar statistical software (FERREIRA, 2014).

RESULTS AND DISCUSSION

According to the variance analysis, there was a significant difference between treatments, for which only the witness presented the highest pH values and electrical conductivity when compared to the other treatments using the gongocomposites (Table 1). Shmitz et al. (2012) considered that ideal pH values for organic substrates must stay in the 5.0 to 6.5 range. In this work, the substrates presented high pH values, which indicates a higher susceptibility of the seedlings to the toxicity caused by salts and by chemical elements, possibly limiting the complete development of the root system and reducing the nutrients absorption capacity. It is worth noting that only the witness (Plantmax® substrate) presented a more alkaline pH, however this physical characteristic did not limit the production of vigorous, commercially viable seedlings.

TABLE 1 - pH, electrical conductivity (EC), carbon/nitrogen ratio (C/N), and macronutrient content of the organic substrates used in the crisp lettuce seedlings production.

Substrates	pH	EC ($dS\ m^{-1}$)	C/N	Macronutrient content ($g\ kg^{-1}$)					
				N	C	P	K	Ca	Mg
T1	7.33 b*	1.25 b	19.09 d	21.41 a	408.64 c	1.81 b	5.49 b	24.65 b	6.52 b
T2	7.50 b	1.22 b	26.42 a	16.28 b	430.13 a	1.48 b	5.86 c	20.78 c	3.19 c
T3	7.30 b	1.22 b	23.35 c	17.86 b	417.11 b	1.74 b	5.10 b	21.74 c	2.84 c
T4	7.43 b	1.26 b	22.78 b	28.54 a	432.28 a	5.99 a	6.27 a	27.15 a	7.89 a
T5	8.13 a	2.11 a	21.57 b	15.15 d	326.73 d	5.25 a	6.27 a	14.95 d	7.06 a
CV(%)	3.50	2.00	4.50	4.50	23.00	3.50	3.60	4.70	5.60

*Same letters in a column indicate the entries are statistically equal by the Scott-Knott test at 5% error probability. N = nitrogen, C = carbon, P = phosphorous, K = potassium, Ca = calcium, Mg = magnesium.

Araújo Neto et al. (2019) stated in their study that the ideal EC values should be between 1.0 and 2.0 $dS\ m^{-1}$. Thus, it can be seen in Table 1 that all evaluated gongocomposites presented EC values within this range, except the witness (Plantmax®), which had EC over the limit, confirming that the waste in the substrates caused the reduction of the electrical conductivity.

Evaluating the carbon/nitrogen ratio (C/N) and the nitrogen (N) content, higher correlations and macronutrient concentrations can be seen for treatments T1 and T4 compared to the other treatments. The organic matter content and the C/N ratio are considered important properties for the substrates. Organic matter acts on the substrates by enhancing these physicochemical characteristics, where the main benefits are the increase on the water retention capacity, total porosity, aeration gaps, and density reduction, also making the substrate a source of nutrients (STEFFEN et al., 2010).

The treatment using waste from the almond tree and Siamese cassia, *oitizeiro*, and lebbek tree affected the N cycle in the soil-plant system, making organic N from the soil available to the seedlings via the biomineralization process defined as the transformation of N in its organic form into its inorganic form (ammonia - NH_3 or ammonia ions - NH_4^+), carried out by the soil microorganisms that use organic compounds as energy source (REIS et al., 2012). Hence, it proves that the biomineralization of the organic N in the soil is due to the action of millipede populations, such as the *Trigoniulus corallinus*, that decomposes organic matter. N in the soil can also turn, due to these microorganisms, into gaseous forms (nitrous oxide - N_2O or elementary nitrogen - N_2), which are released into the atmosphere in a process known as denitrification, common in wet soil or in other conditions that favors the lack of oxygen (FURTINI NETO et al., 2011).

Higher concentrations of C were obtained on treatments T2 and T4 when compared to the other treatments. It is worth noting that this gongocomposite outstood for the production of C due to the decomposition of carbonated substances by the microorganisms' action on the soil, which use waste components (leaves, sticks, *etc*.) as a source of energy, producing cell substances with high concentrations of ATP, carbohydrates, and phospholipids, essential to the initial seedling development (ANTUNES et al., 2016).

For the phosphorous (P), potassium (K), and magnesium (Mg) contents it is possible to observe a significant difference between the treatments, where the highest concentrations of these elements were obtained for T4 and for the witness when compared to the other treatments, reaching variations of 255%, 23%, and 49%, respectively. This is explained by the fact that Plantmax® is a commercial substrate produced with expanded vermiculite and organic matter from vegetables, coconut powder, which are materials considered to be in the ideal range for supplying macro and micronutrients responsible for the development of edible vegetable seedlings. Regarding T4, it can be stated that this organic compound favored the complexation of metals and organic acids generated on the decomposition of this waste, increasing the availability of cations in the solution by the action on these metals' adsorption places. Normally, Ca and Mg amounts increase in the solution because of the addition of vegetable waste like *oitizeiro* and leucine.

The calcium (Ca) concentration outstood only on treatment T4, reaching 82%, enabling one to state that such organic compound favored the complexation of metals with the organic acids generated by the decomposition of this waste, increasing the availability of cations in the solution by the action on the adsorption places of these metals. Normally, the amount of Ca and Mg increase in the solution because of the addition of vegetable waste (PAVINATO; ROSOLEM, 2008) from the pruning of vegetable species like *oitizeiro* and lebbek tree.

Analyzing the physical characteristics of the substrates, it is possible to notice significant differences between the treatments, where T2 and T4 present better macroporosity (MAC) results, T4 and T5, better microporosity (MIC) results, T4 has the best total porosity (POT) and moisture retention capacity (CRA), and T4 and T5, better volumetric density (DV), when compared to the other treatments (Table 2). The porosity can be defined as the ratio between the soil or substrate volume not occupied by solid particles, influencing the air and water dynamics inside the substrate.

TABLE 2 - Macroporosity (MAC), microporosity (MIC), total porosity (POT), moisture retention capacity (CRA), and volumetric density (DV) of the substrates used in the production of crisp lettuce seedlings.

Substrates	MAC	MIC	POT	CRA	DV
	(%)			(mL cm^{-3})	(kg m^{-3})
T1	28.55 c*	53.01 b	81.56 c	29.79 c	162.27 d
T2	35.61 a	46.93 c	82.54 c	23.73 d	165.30 c
T3	29.46 b	53.60 b	83.06 b	30.61 b	162.70 d
T4	35.09 a	58.00 a	88.09 a	35.22 a	179.30 a
T5	26.55 c	56.56 a	83.11 b	33.65 b	371.20 a
CV(%)	4.50	7.80	9.00	5.80	15.00

*Same letters in a column indicate the entries are statistically equal by the Scott-Knott test at 5% error probability.

However, T2 and T4 presented more uniform particles, which provided the soil with higher porosity. These substrates were more particle-uniform, resulting in the filling of the existing gaps, achieving higher aeration, and consequently favoring the seedlings performance. According to Bugni et al. (2019), the proper ratio of micropores in substrates must lie in the range from 45 to 55%, which was verified in the substrates yielded in this work. The micropores are filled by water, thus any action that reduces larger pores will decrease the air ratio in the substrate, which is a consequence of compacting because as the pressure over the substrate increases, the larger pores diminish, reducing the available air volume and increasing the retained water amount, which limits the growth of plants (STEFANOSKI et al., 2013).

This compacting can be higher or lower depending on the use of the irrigation system, causing different density values. Soils and substrates are porous media, formed by solids and pores filled with water or air. The pores are responsible for the gases exchange between the substrate and the atmosphere, as well as for the determination of the water movement in pots and for drainage (BUGNI et al., 2019).

In order to succeed on the seedlings production, it is paramount to understand the dynamics of the relations between solids and pores in the organic composites. According to De Bootd; Verdonck (2012), the ideal substrate must have between 75 and 85% of its volume composed of pores (total porosity). However, the proper volumetric density range of substrates for the production of seedlings on trays is between 100 and 300 kg m^{-3} (Table 2). Plantmax® presented higher density than the gongocomposites and lower macropores ratio, which can be understood by the presence, due to formulation, of elements with lower particle diameter.

The substrate on T4, with higher volumetric density, however, was not in this range probably because the mixture of *oitizeiro* and lebbek tree leaves and fine sticks was more palatable to the *gongolos*, and thus, more chipped. T4 presented higher chipping level, resulting in lower particle size at the end of the gongocomposition process. The total porosity, as well as the volumetric density, directly influences the plant water and nutrient absorption process.

Substrates T4 and T5 presented higher moisture retention capacity. Since it is known that the water excess harms the development of seedlings, there are proper levels of moisture retention in substrates, making it an important inherent physical characteristic of any substrate, especially in the production of edible vegetable seedlings on trays. Considering that tray cells commonly used for edible vegetable seedlings production are tiny, one substrate that presents low moisture retention capacity or that retains water excessively will not be adequate for this goal, causing problems that will affect the vigor and the quality of seedlings due to the hydric deficit or excess in the root system environment, respectively (SEFANOVIC et al., 2016).

However, it is possible to highlight the coherence between the volumetric density results and the moisture retention capacity, which indicates a close relation of these two characteristics. The substrates that have densities in the optimal range are also the ones that present adequate values for the moisture retention capacity.

Treatments T4 and T5 presented the best results for all plant characteristics evaluated, statistically differing from the other treatments (Table 3). Considering the shoot and root fresh biomass, shoot and root system dry biomass, better results were observed when substrates T4 and T5 were used, with results twice as good as the results for other substrates. Lettuce is an edible vegetable with increased nutritional needs in the seedlings initial phase (ENSINAS et al., 2019), therefore, it is possible to say that high concentrations of phosphorous, potassium, and magnesium accumulated in the substrates affect directly the increase of the seedlings' biomasses.

TABLE 3 - Shoot fresh biomass (BFPA), shoot dry biomass (BSPA), root system fresh biomass (BFSR), root system dry biomass (BSSR), roots volume (VR), seedling vigor (VR), and clod stability (ET) of the crisp lettuce seedlings produced in different substrates.

Substrates	BFPA	BSPA	BFSR	BSSR	VR	VM	ET
	------------ mg plant^{-1} ------------				(mL)		
T1	1.80 b*	0.25 b	0.36 b	0.047 a	1.37 b	1.17 b	3.10 b
T2	1.50 b	0.22 b	0.41 b	0.037 a	1.50 b	1.02 b	3.15 b
T3	1.35 b	0.23 b	0.30 b	0.020 a	1.25 b	1.20 b	3.15 b
T4	4.91 a	0.56 a	0.37 a	0.017 a	2.25 a	2.22 a	3.90 a
T5	4.85 a	0.55 a	0.83 a	0.090 a	1.20 a	1.57 b	3.15 b
CV(%)	2.70	2.40	4.20	0.60	2.20	2.00	3.00

*Same letters in a column indicate the entries are statistically equal by the Scott-Knott test at 5% error probability.

Lana et al. (2014) achieved significant values of shoot fresh biomass with high-phosphorous-content lettuce due to the organic fertilization with gradual release of this element to the plants. When the root volume, the seedling vigor, and the clod stability were observed, a significant difference across the treatments could be seen, with T4 presenting the best results when compared to the other evaluated treatments (Table 3). Indirectly, the physicochemical properties of the soil could be enhanced through a self-flocculent effect of the organic matter, thus enhancing the air, water, and nutrients movement, enabling the improvement of the roots' growth and of the root's penetration into the soil. Organic matter supplied by the organic composites, such as the gongocomposite, not only enhances those characteristics, but also stimulates the production of phytohormones, capable of inducing the root system development, providing also a low-cost alternative, reducing the use of chemical fertilizers (GALBIATTI et al., 2017).

According to the results presented in Table 3, the clod stability (ET) in T4 presented better sturdiness, making it easier to remove the seedlings from the trays when compared to the other treatments. It is possible that the granular structure of the coprolites, which compose the waste present in the gongocomposite, has been a fundamental characteristic for the yielding of this great result.

It is possible to see that, according to Table 1, T4 achieved high concentrations of phosphorous content, which possibly caused higher increase of the lettuce seedlings biomass. Meneghelli et al. (2018) stated that, at the beginning of the vegetative cycle in cabbage seedlings, the high availability of phosphorous can affect the development of the shoot and of the root system of seedlings, enabling the plant to recover and yielding high-quality seedlings.

The gongocomposite supplies nutrients to the plants, favors enhancements of the physical and biological qualities of the soil, besides being an organic compound that can be easily handled, presents low cost, and can be easily acquired, which favors a higher quality production. The use of the gongocomposite contributes with the reduction of the environment pollution because much waste from urban pruning can be reused in the production of the decomposition instead of being incorrectly discarded, harming the environment (ANTUNES et al., 2018).

However, it is known that the culture of lettuce responds well to organic fertilization, since it has high requirements for a nutrient-rich soil, which results in an increase on the seedlings production. Studies of this nature in Brazil are still incipient, mainly when it comes to lettuce culture using gongocomposite with the goal of defining the best concentrations to yield high production and high-quality seedlings, also aiming at reaching maximum productivity and uniformity of the plants in the field (RIBEIRO et al., 2012).

CONCLUSION

The gongocomposite developed from a mixture of grass (*Paspalum notatum*) + *oitizeiro* + lebbek tree (40% + 30% of pruning waste + 30% of pruning waste) presented the best physicochemical characteristics and best initial development of lettuce seedlings.

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