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Sensorial analysis of commercial quality of lettuce grown on different substrates

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Abstract: Regional residues of agricultural, livestock and forestry activities can be used in the formulation of substrates that allow the adequate supply of nutrients in family agricultural production. The objective of this research was to determine the efficiency of different formulations of substrates enriched with babassu biochar for the commercial development of lettuce through sensorial analysis. The experiment was conducted in the period from November 2016 to February 2017. The design was completely randomized, with nine treatments and 15 replicates. Dystrophic Yellow Latosol (dYL), increasing doses of biochar (B); organic fertilizer (OF) and mineral fertilizer (MF) were used in the substrate preparation. The treatments evaluated were: S1 = dYL, S2 = dYL +10 t ha-1B, S3 = dYL +20 t ha-1B, S4 = dYL 30 t ha-1 B, S5 = dYL + 2 t ha-1 OF, S6 = dYL + 5 t ha-1 OF, S7 = dYL +8 t ha-1 OF, S8 = dYL +10 t ha-1 B + 2 t ha-1 OF, S9 = dYL + MF. At 80 days after sowing, sensory analyzes were carried out in order to judge the visual characteristics of the lettuce per treatment. Based on the multicriteria analysis the S4 substrate, the one that contain 30 t ha-1 of biochar proved to be the most successful substrate to comply with the study variables. Thus, the use of biochar can be considered as a viable alternative to mineral fertilizer in terms of sensory analysis.
Keywords:: Biochar, Babassu, Chicken bed litter. *Lactuca sativa* L. Organic fertilization.

Introduction

The substrate must provide nutrients, perfect aeration and humidity for the growth and development of crops. One of the major problems is the high cost of commercial substrates and their lack of essential nutrients for initial development. (Cavalcante et al., 2012). Thus, alternative substrates and formulations are proposed using low cost and regional availability inputs that do not compromise the quality and viability of production (Pelizza et al., 2016; Cordeiro et al., 2018).

In addition, the effects of climate change need to be increasingly considered in new sustainable farming systems, which increase organic matter in soils and contribute to carbon sequestration. These aspects are considered by the international "4 per 1000" program approved in the Paris agreement at COP 21, with biochar being one of the most explored and relevant alternatives to meet this double challenge, especially in the semi-arid regions.

An input option for lettuce producers in Brazil, especially in the states of Maranhao, Piaui and Tocantins, is the residual transformed biomass of babassu palm (Attalea speciosa Mart.) Converted via pyrolysis. Biochar is used in substrates because it is rich in carbon and obtain water retention capacity (Salinas et al., 2018). The physical and chemical properties of the soil influence soil properties, improving fertility and nutrient use efficiency, which, consequently, increases crop productivity (Lehmann, Joseph, 2009).

The application of the chicken bed litter correctly as a component of the substrate can promote improvements in soil attributes, increasing its fertility, and most of these benefits are attributed to organic matter, which influences the soil properties and may also present as well as changes in soil physical properties favoring plant development (Palhares et al., 2011).

Adequate choice of substrate for the development of certain crops may result in positive sensory characteristics for their consumption, referring to the texture, flavor, aroma, shape and color of lettuce (Fellows, 2006). In addition, the sensory tests used the human sensory organs as instruments, have been shown to be an important tool to measure positive sensory characteristics and consumer acceptance (Bernardi et al., 2005; Ferreira et al., 2015). For a product to be consumed it must be attractive to the consumer, but it is essential that the product has a good appearance (Lermen et al., 2015).

Lettuce (Lactuca sativa L.) originates from the Mediterranean region, and was introduced in Brazil by the Portuguese in 1650 (Sala & Costa, 2012). It is currently the most popular of leafy vegetables, being cultivated in almost all regions of the world (Suzuki et al, 2018). In Brazil it is one of the most consumed vegetables, whose annual consumption is on average 27 kg person-1 (IBGE, 2011).

The cultivation of lettuce has economic, food and social importance, considering the high consumption and income generation of family farmers, since their participation is predominant in the supply of the Brazilian market (Gazola et al., 2015). It is estimated that Brazil has an area of 79,800 hectares planted with lettuce, characterized by intensive production, cultivation in small areas and family production, generating around five jobs per hectare (Camargo et al., 2012).

The success of lettuce cultivation lies in the relationship between quality and price of the product, these factors can be considered the main parameters observed by the consumers, and consequently the main requirements for a production with conditions of competitiveness in the market (Paulus et al., 2010).

One of the main aspects related to quality and profitability in the cultivation of vegetables resides in the type of substrate used (Cordeiro et al., 2018), as it may interfere with the germination, formation and development of the crops (Pelizza et al., 2016). Therefore, due to the importance of the lettuce culture and the influence that the substrate provides in the final results, the objective of this research was to determine the efficiency of different substratum formulations for the commercial development of butter-head cultivar, through sensory analysis.

In the present study, it was found that the quality of the fruit and vegetables was higher than that of the other cultivars (Peltier et al., 2006). Therefore, due to the importance of the lettuce culture and the influence that the substrate provides in the final results, the objective of this research was to determine the efficiency of different substratum formulations for the commercial development of butter-head lettuce cultivar, through sensory analysis.

Methods

The experiment was conducted at the Agricultural and Environmental Sciences Center of the Federal University of Maranhao (UFMA – Universidade Federal do Maranhao), located in Chapadinha town - MA - Brazil (03º44'28.7 "S and 43º18'46" W), at 107 m altitude), the climate classification is Aw according to Köppen and Geiger, with annual mean rainfall of 1670 mm and annual mean temperature is 27 ° C (Passos et al., 2016).
The experiment was performed in a greenhouse with 50% brightness, from November 2016 to February 2017. Figure 1 shows the average temperature and precipitation conditions during the experiment period.

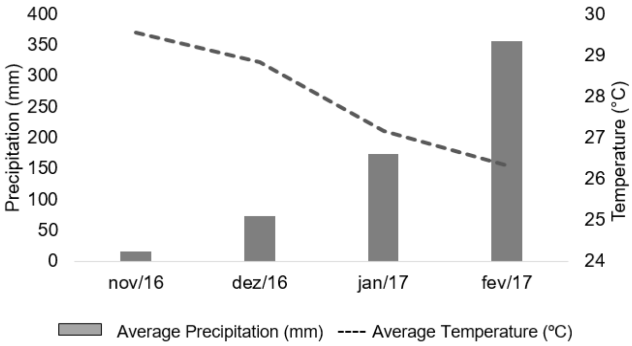

Figure 1 -Precipitation and average temperature in Chapadinha - MA during the production period butter-head lettuce on differentsubstrates
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The experiment was conducted in a completely randomized design with 9 treatments and 15 replicates, totaling 135 experimental units. The composition of the evaluated substrates is described in Table 1.

Table 1. Treatments analyzed in butter-head lettuce production.

Treatments	Formulations
S1	dYL
S2	dYL +10 t ha^{-1}B
S3	dYL +20 t ha^{-1}B
S4	dYL 30 t ha^{-1} B
S5	dYL + 2 t ha^{-1} OF
S6	dYL + 5 t ha^{-1} OF
S7	dYL +8 t ha^{-1} OF
S8	dYL +10 t ha^{-1} B + 2 t ha^{-1} AO
S9	dYL + MF

Dystrophic Yellow Latosol (dYL), babassu palm biochar (B), chicken bed litter as organic fertilizer (OF) and mineral fertilization (MF).

The substrates were prepared and distributed in plastic containers with a capacity of 5 L. The soil used in the experiment was classified as a dystrophic Yellow Latosol (LAd) (Santos et al., 2013), with a sandy loam texture and the following chemical characteristics: pH (CaCl2) = 4.5; Al + 3 (mmol c dm-3) = 5.0; Ca + 2 (mmol c dm-3) = 14.0;

Mg + 2 (mmol c dm-3) = 7.0; P Resin (mg dm-3) = 8.0; K (mg dm-3) = 50.83; Organic matter = 15 (mg dm-3); V (%) = 44.8; Base Sum 24.3 (mmol c dm-3); CTC = 54.3 (mmol c dm-3). Biochar was prepared using as a precursor material the central leaf branch of Babassu palm (Attalea speciosa Mart.), The pyrolysis temperature was 500 ° C with a heating rate of 5 ° C min-1. The biochar produced was analyzed in the laboratory and showed the following characteristics pH = 9.62; Moisture Content (%) = 3.57; Ash content (%) = 7.79; Volatile materials (%) = 13.56; Fixed Carbon (%) = 78.65; N (%) = 0.37; C (%) = 67.46; H (%) = 2.74 (Parra-Serrano et al, 2016).

In relation to the S9 treatment, the mineral fertilization was carried out according to the result of the soil analysis and following the crop needs as recommended by Alvarez et al. (1999), applying 20% of the nitrogen (0.00170 kg ha-1), 20% of the potassium (0.00007 kg ha-1) and 100% of the phosphorus (0.00243 kg ha-1) in the planting, recommending , the remaining nitrogen (80%) and potassium (80%), divided in three times, were applied to the cover fertilizations at 15, 30 and 40 days after transplanting.

The butter-head lettuce cultivar used in the research is characterized by smooth, loose and delicate leaves without the formation of a compact head, were produced in polyethylene trays with 128 cells, containing organic substrate prepared with goat manure and babassu palm biomass decomposed. After 15 days of sowing (DAS) the thinning was performed and when the plants had four well developed leaves the transplanting was done at 30 DAS for the plastic vessels.

At 80 DAS, sensorial analyzes were performed by fifty volunteers. They were previously informed about the objective of the research and received a form to judge the visual characteristics of the product by treatment, for which a hedonic scale was established of three characteristics that would depend on the perception of each consumer and with that to determine a note by your purchase criteria (notes: 10, 7.5 and 3.5).

The percentage of acceptability of the consumers was evaluated in relation to color, quantity of defects, commercial size, firmness, appearance and potential of purchase. The data were submitted to analysis of variance, the mean values being compared by the Tukey test at 5% of significance, using the statistical program InfoStat® v. 2008.

Results and discussion

The percentage of consumer acceptance regarding the color of lettuce grown in the nine treatments is shown in figure 2. It is observed that in this criterion the highlight was for treatments S3, S4 and S5 that obtained the best values of acceptance.

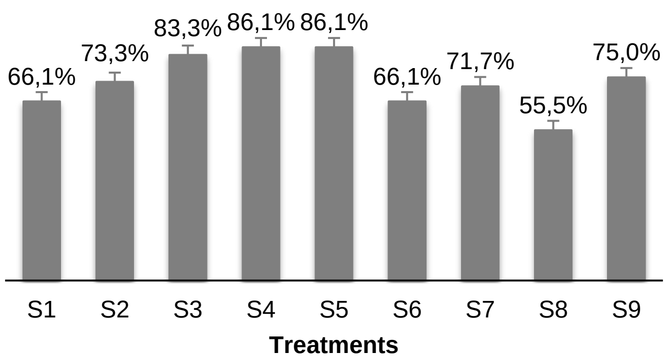

Figure 2 - Percentage of acceptability of consumers regarding lettuce color. Equal letters do not differ statistically in the Tukey test at 5% significance.

The highest percentages involving the three treatments (S3, S4 and S5) may be related to the better physical conditions of the substrate and nutrient supply. Blackwell et al. (2015) have demonstrated that the addition of biochar to the soil can increase nutrient availability. This increase in fertility may result in improved plant performance and increased nutrient concentrations in its tissue and its use associated with organic fertilizers improves the physical, chemical and biological characteristics of soil (Glaser et al., 2002; Silva et al. 2010), resulting in a more vigorous and well-nourished plant with vivid and attractive colors, thus being important for the judgment of consumer buying.

The relevance of this criterion is due to the fact that color is one of the priority characteristics and thus constitutes the first criterion for its acceptance or rejection. According to Cobucci (2010), color is one of the attributes that have the greatest impact on the consumer evaluation of a specific product, the consumer expects products to have a characteristic color, avoiding products whose color is not as expected. The defects that the lettuces presented were also evaluated (Figure 3), where defects are defined as burns, marks associated with pest attack and other visual characteristics that detract from the appearance of the product. From the results analyzed the treatments S4, S5 and S6 presented the best acceptance rates in this criterion.

According to Almeida et al (2017) one of the main characteristics of the current vegetable market is the size of what these are presented to the consumer, in all its variations. Larger vegetables, in the case of lettuce, are more attractive in the eyes of the consumer.

In relation to the evaluators' perception of the size of the lettuce cultivated in each substrate, in Figure 4, where the lettuces of the treatments S2, S3, S4, S5, S6 and S8 were the best according to the evaluators and they did not differ statistically, showing that the biochar doses in the proportions of dYL + 10, 20 and 30t ha-1, organic fertilization in the proportions of dYL + 2 and 5t ha-1 and mixture of dYL + 10t ha-1 of biochar with dYL + 2t ha-1 of organic fertilizer may be satisfactory for a good size formation of the lettuce, surpassing even the mineral fertilization as shown by these results.

Another factor analyzed by the consumers was the firmness of the lettuce (Figure 5). For Russo (2013) firmness is an important attribute in the quality of fruits and vegetables, since it affects the resistance to transport, the attack of microorganisms and the very sensorial characteristic of the fruits. In view of this, the best results in this respect were found in treatments S3, S4 and S9.

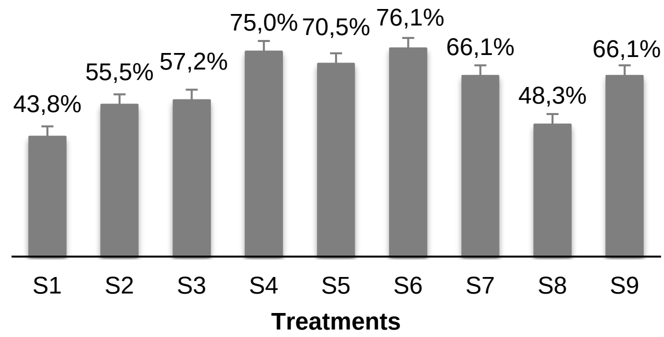

Figure 3 - Percentage of acceptability of consumers regarding the amount of defects of lettuces grown on different substrates. Equal letters do not differ statistically in the Tukey test at 5% significance.

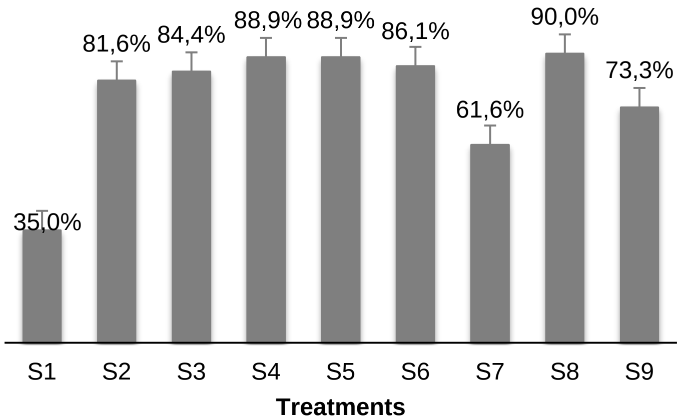

Figure 4 - Percentage of acceptability of consumers regarding the commercial size of lettuces grown on different substrates. Equal letters do not differ statistically in the Tukey test at 5% significance.

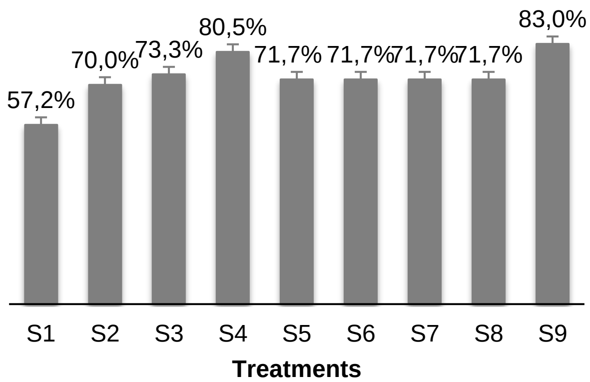

Figure 5 – Percentage of consumer acceptability regarding the firmness of lettuce grown on different substrates. Same letters do not differ statistically in the Tukey test at 5% significance

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The lettuce produced in the dystrophic Yellow Latosol (control), as expected, presented the lowest percentage of acceptance regarding its firmness. According to Russo et al. (2013), the decrease in firmness is closely related to the solubilization of pectic substances and that during maturation the pectin insoluble in soluble pectin converts, softening and decreasing the resistance of fruits and vegetables.

According to Lana (2016) external appearance of vegetables is of great importance because the consumer when choosing a vegetable usually is guided mainly by the appearance of the product. Damaged vegetables may cause changes in the taste, texture and nutritional value of the food and in some situations pose a health risk. Thus, a variable closely linked to quality.

In figure 6 it possible to see the representative percentages of this criterion according to the consumers' responses, where the S4 and S9 treatments presented the highest percentages of acceptability, 80.5% and 73.3%, respectively. The lowest acceptance (35%) was recorded for the lettuce produced in the control treatment.

After carrying all these characteristics of color, amount of defects, size, firmness and overall appearance of a greenery is that the consumer will decide if this food is suitable to take to your table and if it suits your preferences. Taking this into consideration the last question of the questionnaire referred to a possible purchase of lettuces grown on each substrate.

Based on the notes given by the consumers, it was possible to reach the average percentages of acceptability for the purchase expressed in Figure 7. It can be noticed that the treatments with the highest purchase potential were S4 and S5, both with acceptability of 90%, being superior to the adduction (S9), but the three did not differ statistically.

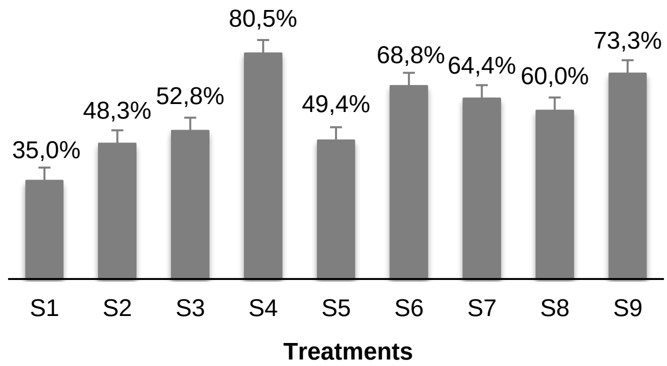

Figure 6 - Percentage of coverable use for one aspect of lettuces grown on different substrates. Letters are not statistically the same in the Tukey test at 5% significance.

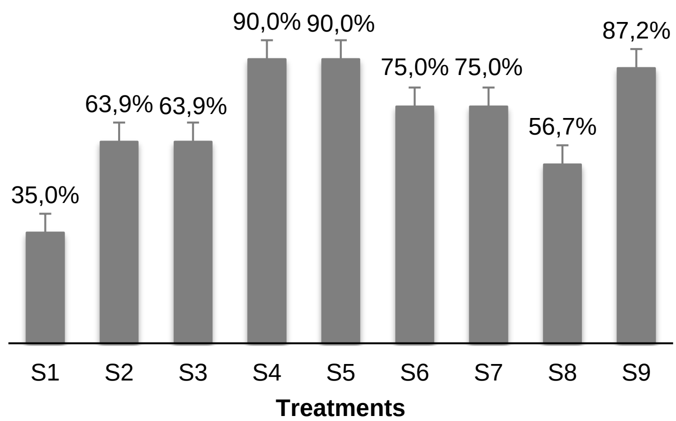

Figure 7 - Percentage of acceptability of consumers regarding the purchase of lettuces grown on different substrates. Equal letters do not differ statistically in the Tukey test at 5% significance.

Sensory analysis was an adequate tool to evaluate quality and external appearance. Thus the use of a visual analysis was adequate to differentiate and classify the lettuces grown on different substrates.

Conclusions

Both biochar and organic fertilization showed satisfactory results in the visual and commercial quality of lettuces, thus being a viable alternative to mineral fertilization, since it obtained similar results. However, taking into account all the sensory

variables studied, a higher overall performance of the S4 substrate developed with a concentration of 30 t ha-1 of babassu biochar is observed. This result indicates the potential of biochar in the sensorial analysis of the consumer, besides its possible agronomic and environmental interests.
The sensorial analysis was an adequate tool to evaluate the quality of the lettuce as well as the preference of the consumer.

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