

USE OF DREGS FROM FAT AND RESIDUARY OIL PURIFICATION IN COMPOSTING

USO DA BORRA DA PURIFICAÇÃO DE GORDURAS E ÓLEOS RESIDUÁRIOS EM COMPOSTAGEM

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ABSTRACT

The global concern about searching for alternatives to fossil fuels has found solutions in agricultural fields and the use of waste to produce biodiesel. The aim of this study was to point out the best substrate composition for dregs compost originated in the extraction of biodiesel from frying oil waste. Two experiments were conducted, one in field and the other in greenhouse. The field experiment was set up in order to obtain compost from chopped napier grass, added to cattle manure or castor bean, using different dosages of fat dregs and residuary oil. The greenhouse experiment were set in order to test the composts derived from the field experiment, the test plant used was sorghum. The dregs, in any dosage, may be recycled within the composting process without affecting the final product. Composts made of napier grass with cattle manure presented electrolytic conductivity more

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suitable to be used as organic fertilizer. The addition of castor pomace to the compost mass resulted in nutritionally richer final products. Composts made of napier grass + castor pomace provided larger yields of biomass than composts made of napier grass + manure.

Keywords: Biodiesel. Castor pomace. Cattle manure. Byproduct. pH.

RESUMO

A preocupação mundial, relativa à busca de alternativas aos combustíveis fósseis, vem encontrando soluções nos campos agrícolas e no uso de resíduos para produção de biodiesel. Objetivou-se com este trabalho verificar a melhor composição de substratos para compostagem da borra resultante da extração do biodiesel de gorduras e óleos residuários de frituras de alimentos. Dois experimentos foram realizados, um em campo e outro em casa de vegetação. O experimento de campo foi implantado a fim de obter composto orgânico a partir de capim napier picado, adicionado ao esterco bovino ou resíduo de mamona, utilizando diferentes doses da borra de óleos de frituras de alimentos. O experimento em estufa foi realizado a fim de testar os compostos provenientes da etapa de campo, a planta teste utilizada foi sorgo. A borra, nas doses utilizadas, pode ser reciclada por meio de compostagem sem afetar o produto final. Compostos de capim napier com esterco de bovinos apresentam condutividade eletrolítica mais adequada que compostos de capim napier com torta de mamona. Adição de torta de mamona ao composto resultou em produtos finais mais ricos nutricionalmente. Compostos de capim napier com torta de mamona, propiciaram maior produção de biomassa que os de capim napier com esterco.

Palavras-chave: Biodiesel. Torta de mamona. Esterco de bovinos. Sorgo. Fritura de alimentos.

INTRODUCTION

The global concern about searching for alternatives to fossil fuels has been increasingly finding solutions in agricultural fields and in the use of waste. Broadening the options for energy source is one way to seek renewable sources that could gradually replace using fossil fuels. In Brazil, biodiesel is a viable alternative to diesel and can be obtained through reactions between vegetable oil and alcohol in the presence of a catalyst (Lima et al., 2009). The authors stress that, for the production of raw material to obtain biodiesel, large volumes of waste are generated and, when these are discarded in inappropriate places can cause environmental pollution. As examples of these wastes, it is possible to mention

the dregs resulting from the recycling residual oil and fats from fried foods, which still does not have a proper destination.

Pitta Junior et al. (2009) affirm that, due to lack of information, much of the frying oil, along with its dregs, ends up being discharged directly into sinks, where it is carried into the sewage systems, causing damage and clogging of pipes, increasing the cost of treatment in plants and pollution of the aquatic environment. When this waste is placed in household trash, it contributes to the need of increasing the landfills areas. However, these wastes, if properly processed, may be used as a valuable source of nutrients for crops and a way to process them is by composting. □

Composting is a practice that allows transforming materials that are unsuitable to be used in their original form as nutrient source for plants and conditioning agent of the physical, chemical and biological properties of the soil (Sanchez-Monedero et al., 2001). Therein, the aim of this work is to investigate which is the best substrate composition to process the dregs originated in the production of biodiesel from fats and frying oil, using napier grass as carbon source and castor bean or cattle manure as nitrogen source, substrates available in the study region and recommended as inoculant and source of carbon.

MATERIAL AND METHODS

Two experiments were conducted, one in field and the other in greenhouse at the Agriculture Department, Universidade Federal de Lavras (UFLA), in Lavras – MG, Brazil, geographic coordinates: latitude 21 ° 14'S, longitude 45 ° 00'W and 918 m asl. The climate in the region, according to Köppen climate classification is Cwa, rainy temperate (mesothermal), with dry winter and rainy summer, subtropical (Dantas et al., 2007).

The field experiment was set up in order to obtain compost from chopped napier grass, added to cattle manure or castor bean, using different dosages of fat dregs and residuary oil (Table 1).

The Field experiment was outlined in a completely randomized design (CRD), under 3 replications (Table 1).

The greenhouse experiment were designed to observe the performance of the obtained composts over sorghum. The chemical characteristics of napier grass, cattle manure and castor pomace are found on Table 2.

Table 1 Treatments (experiment in field) mixed to organic material used for composting and treatments (experiments in greenhouse).

Treatments	Abbreviation
Composting experiment (field):	
0.75 m ³ napier grass + 0.25 m ³ cattle manure + 5L of sludge	NM5
0.75 m ³ napier grass + 0.25 m ³ cattle manure + 10L of sludge	NM10
0.75 m ³ napier grass + 0.25 m ³ cattle manure + 15L of sludge	NM15
0.75 m ³ napier grass + 0.25 m ³ cattle manure + 20L of sludge	NM20
0.75 m ³ napier grass + 0.25 m ³ castor pomace + 5L of sludge	NCP5
0.75 m ³ napier grass + 0.25 m ³ castor pomace + 10L of sludge	NCP10
0.75 m ³ napier grass + 0.25 m ³ castor pomace + 15L of sludge	NCP15
0.75 m ³ napier grass + 0.25 m ³ castor pomace + 20L of sludge	NCP20
Experiments in vases (greenhouse):	
Soil mixed with the compost NM5 proportion 110 g.vase ⁻¹ (7.3 t.ha ⁻¹)	
Soil mixed with the compost NM10 proportion 115 g.vase ⁻¹ (7.7 t.ha ⁻¹)	
Soil mixed with the compost NM15 proportion 121 g.vase ⁻¹ (8 t.ha ⁻¹)	
Soil mixed with the compost NM20 proportion 121 g.vase ⁻¹ (8 t.ha ⁻¹)	
Soil mixed with the compost NCP5 proportion 66 g.vase ⁻¹ (4.4 t.ha ⁻¹)	
Soil mixed with the compost NCP10 proportion 76 g.vase ⁻¹ (5.1 t.ha ⁻¹)	
Soil mixed with the compost NCP15 proportion 78 g.vase ⁻¹ (5.2 t.ha ⁻¹)	
Soil mixed with the compost NCP20 proportion 83 g.vase ⁻¹ (5.5 t.ha ⁻¹)	
Non fertilized soil (control)	

Source: Table made by the author.

NM5 = Napier + manure + 5 l de residuary sludge, NM10 = Napier + manure + 10 l de residuary sludge, NM15 = Napier + manure + 15 l de residuary sludge, NM20 = Napier + manure + 20 l de residuary sludge, NCP5 = Napier + castor pomace + 5 l de residuary sludge, NCP10 = Napier + castor pomace + 10 l de residuary sludge, NCP15 = Napier + castor pomace + 15 l de residuary sludge, NCP20 = Napier + castor pomace + 20 l de residuary sludge.

Table 2 Chemical characteristics of the used wastes.

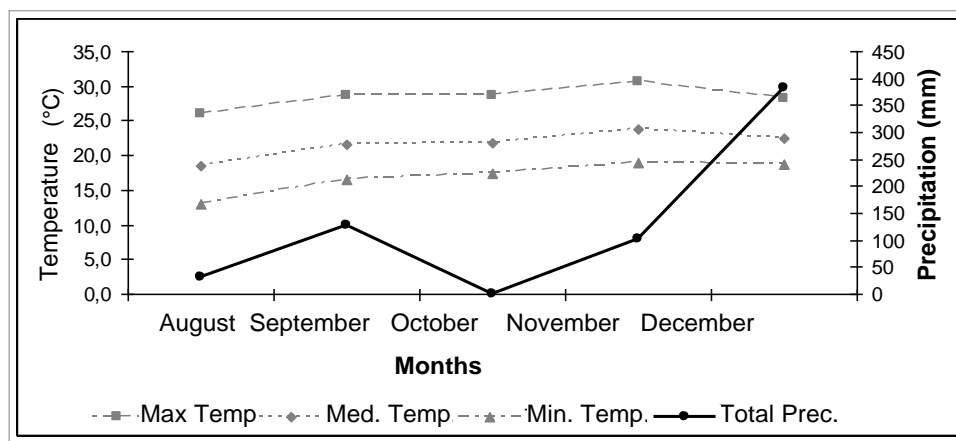
Wastes	B	Zn	Ca	P- Total	K- Total	N- Total	C- Total	C/N Ratio
	--- mg.kg ⁻¹ ---			----- g.kg ⁻¹ -----		----- % -----		
Napier	6	638	2.0	0.8	3.5	0.57	46.5	82/1

Grass								
Castor Pomace	14	81	4.6	6.6	9.0	4.18	49.3	12/1
Cattle Manure	11	181	10.7	5.00	7.6	1.90	30.4	16/1

Source: Table made by the author.

The experiment lasted 120 days, from August to December 2010. The temperature and rainfall data are found on Figure 1. These data were provided by the Sector of Agrometeorology, in the Department of Engineering at UFLA.

Figure 1 Climate diagram (temperature and rainfall) from the period when the field experiment was conducted.



Source: Graph made by the author.

The cells were made in a composting area under field conditions in direct contact with soil, the win-drow system was used, with an initial volume of 1m³. The ratios used were 1:3, one part of cattle manure + three parts of napier grass or one part of castor pomace + three parts of napier grass, as recommended by Rashid et al. (2001).

It was considered a split-plot scheme containing a 2x4 factorial within each parcel. In parcel, the first factor was composed by the materials napier grass + cattle manure and napier grass + castor pomace, and the second, by four doses of fat dregs and residuary oil (5, 10, 15 and 20L), adding up to 8 treatments. Each parcel was splitted along time (60, 90 and 120 days).

When the cells reached constant temperature the composts were dried and subjected to laboratory analysis of their chemical characteristics (Calcium, Boron, Zinc, Phosphorus, Potassium, Nitrogen and Carbon). The method used to obtain these parameters were: for Zn and P, nitric perchloric injection, according to Abreu et al. (2001); N was measured by the Kjeldahl method; K (digested in aqua regia), C (measured by ash content) and B according to the methods described by Melo & Silva (2008).

The greenhouse experiment were set in a completely randomized design, in a factorial scheme $2 \times 4 + 1$, totaling 8 treatments + a further portion as control (Table 1) in three replications.

The experiment was conducted from April to May 2010 in a greenhouse at the Department of Agriculture – DAG at UFLA. The average temperature during this period was 21.0°C in April and 18.5°C in May and the relative humidity was 69% in April and 59% in May. These data were provided by the Sector of Agrometeorology in the Department of Engineering at UFLA.

The compost amounts were determined according to the nitrogen recommendation for production of sorghum, 60 kg ha⁻¹ (Ribeiro et al., 1999). The N content in each compost was defined by using conversion rate of 50% of nutrient. The test plant used was sorghum (*Sorghum bicolor*), due to its rapid growth and good yields of biomass. The seeded Sorghum was hybrid forage, category S1, which shows good biomass yield. After germination three plants were kept per pot, moisture was kept close to field capacity.

After 30 days of sowing, sorghum was cut at the stem base and weighed to obtain fresh biomass. Afterwards it was dried in a kiln, at 70°C with air renewal and circulation, until weight stabilization, to determine dry biomass.

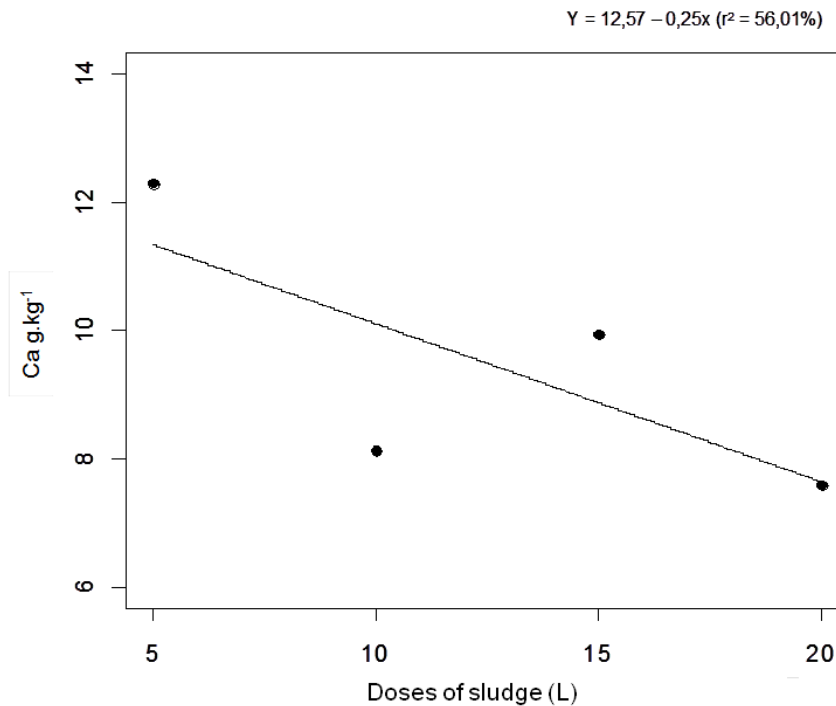
The Sisvar software was used to analyze the data (Ferreira, 2008). ANOVA analyses were performed, followed by regression analyses and Tukey test at 5% significance level. The *software* R was used to develop the graphs (R Development Core Team, 2010).

RESULTS AND DISCUSSION

With the obtained data, it was verified that was a significant interaction for the addition variable of cattle manure or castor pomace to napier grass and doses of fats and residuary oil from the composted material only for calcium. There was significant interaction for phosphorus, zinc, nitrogen, carbon, organic matter and C / N ratio for the addition of cattle manure or castor pomace to napier grass.

For Ca, it was verified that the compost made of the mixture with cattle manure and napier grass showed no statistically different levels of Ca, by adding different doses of dregs from fats and residuary oil, with average value of 10.13g.kg^{-1} . As for the compost made of the mixture with castor pomace and napier grass, the dregs dose of 5L showed higher amounts of Ca and the dose of 20L, lower amounts (Figure 2). The remaining doses did not differ statistically. It can be inferred that by adding greater amounts of dregs to the castor pomace dilution in Ca happens in the final compost.

Figure 2 Ca contents in different doses of sludge from fats and residuary oils added to the composts with castor pomace.



By adding different doses of biodiesel dregs to the composts with napier grass + cattle manure and napier grass + castor pomace, no significant differences were observed in the composts obtained for the nutrients N, P and K. However, when comparing only composts with manure and castor pomace additives, they differed statistically in levels of P (Table 3). The composts with castor pomace presented higher P contents than the ones obtained from manure. For N and K there was no significant difference. As for P, the higher contents of castor pomace reflected on the final compost where obtained compost made of castor pomace was richest in this element. For the K and B there was no significant difference.

Table 3 Differences presented between the composts ready to use in reference to the nutrients / parameters N, P, K, Zn, B, N, C, MO and C / N ratio.

Nutrient	Napier Grass + Cattle Manure	Napier Grass + Castor Pomace
N (%)	2.08 b	3.21a
P (g.kg⁻¹)	2.46 b	7.56a
K (g.kg⁻¹)	3.70 a	5.10a
Zn (mg.kg⁻¹)	149.33 b	185.17a
B (mg.kg⁻¹)	12.6 a	14.0a
N (%)	2.08 b	3.21a
C (%)	30.33 b	38.92a
OM (%)	61.17 b	78.50a
C/N	15/1 a	12/1b

Within each line, averages followed by the same letter do not differ according to the Tukey test (0.05).

By adding different doses of dregs from fats and residuary oil to composts with napier grass + cattle manure and napier grass + castor bean, some significant differences were observed in the compounds obtained for nutrients Zn and B. However, when comparing only compounds with manure and castor pomace additives, they differ significantly in Zn (Table 3). Composts with castor pomace showed higher contents of Zn than the ones obtained with cattle manure, a factor that may be related to a more acidic pH of these composts, according to Abreu et al. (2007), makes Zn available. The pH values at the end of compost process was 4.97 and 6.19 to composts with castor pomace and compost with cattle manure, respectively. For B there was no significant difference.

The addition of different doses of biodiesel dregs in the composts with napier grass + cattle manure and napier grass + castor pomace did not provide significant differences in the parameters C, OM and C / N. However, when comparing only composts with manure and castor pomace additives, they differed significantly on C, MO and C / N ratio (Table 3). The castor pomace compost showed the highest levels of these nutrients / elements, reflecting their greater nutritional value.

As for the C / N ratio, the compost made of the mixing with castor pomace showed the lowest ratio, suggesting that this substrate is more suitable for microorganism activity and that the product is found humified. Fialho et al. (2010) emphasize that the capacity of microorganisms to degrade the organic material is directly related to the C / N ratio, and the efficiency of the composting process will be directly related to the type of substrate used.

By the observation of the data it is verified that the castor pomace compost has a higher nutritional effect when compared to cattle manure compost, resulting in more nutrient-rich material and a lower C / N ratio, suggesting greater maturity of the compost.

The addition of biodiesel dregs did not result in significant effect for fresh and dry biomass of sorghum in the greenhouse experiment. The composts where castor bean was added provided better results for the fresh and dry biomass, when compared with the addition of cattle manure.

Table 4 presents the values of fresh and dry biomass of sorghum after addition of organic composts from the associations napier grass + cattle manure (NM 5, 10, 15 and 20) and napier grass + castor pomace (NCP 5, 10, 15 and 20). Observing the data, it appears that the compounds formed from the combination of napier grass + castor pomace showed larger biomass (fresh and dry) than the composts from the combination of napier grass + cattle manure.

Table 4 Values of fresh and dry biomass from different organic composts (test plant sorghum - *Sorghum bicolor*).

Compost added	Fresh biomass	Dry biomass
	g	
NM5	3.23 b	0.59 b
NM10	3.99 b	0.75 b
NM15	2.43 b	0.43 b

NM20	4.78 b	0.83 b
NCP5	14.94 a	2.48 a
NCP10	21.93 a	3.63 a
NCP15	16.47 a	2.88 a
NCP20	7.83 a	1.46 a
Non fertilized soil (control)	1.85*	0.41*

Within each column, averages followed by the Sam letter do not differ according to the Tukey test (0.05). NM5 = Napier + manure + 5 l de residuary sludge, NM10 = Napier + manure + 10 l de residuary sludge, NM15 = Napier + manure + 15 l de residuary sludge, NM20 = Napier + manure + 20 l de residuary sludge, NCP5 = Napier + castor pomace + 5 l de residuary sludge, NCP10 = Napier + castor pomace + 10 l de residuary sludge, NCP15 = Napier + castor pomace + 15 l de residuary sludge, NCP20 = Napier + castor pomace + 20 l de residuary sludge.

* Different from the average of the factorial.

Source: Table made by the author.

However, it is emphasized that, even if lower, the averages of sorghum fresh and dry biomass, when using manure in combination with napier grass, are still higher than the averages from the control (values 49% and 37% higher for fresh and dry biomass, respectively).

Similar behavior to the experiments are found in other studies, which observed higher production results with the addition of organic compost, as Rashid et al. (2001). Abdelhamid et al. (2004) state that the addition of organic composts results in increased production in the crops. The author also points out that compounds with lower C / N ratios provide higher production in agricultural crops, as observed in this work.

CONCLUSIONS

The fat dregs and residuary oil in any of the tested doses, can be reused through composting, without affecting the final product, when using napier grass substrates mixed with cattle manure or castor pomace.

The addition of castor pomace to the mass of compost results in nutritionally richer final products.

The composts made of napier grass added to castor pomace provided higher fresh and dry biomass yields than composts from napier grass added to manure, regardless of the growing season.

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