

Irradiation of microwaves at rotative cavity in the microbial inactivation of organic sludge from poultry slaughterhouse**Irradiação de microondas na cavidade rotativa na inativação microbiana de lodo orgânico de matadouro de aves**

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ABSTRACT

Microbial inactivation in organic waste is necessary to prevent environmental damage with impacts on vegetation and soil organisms. The objective of this research is process the organic sludge from poultry meats effluents in a microwave oven, aiming at microbial inactivation for its use as organic fertilizer. The sludge, previously dry at open-air, it was subjected to microwave action in the rotative cavity oven, ONDATEC® technology, at different temperatures and exposure time. Microbiological analysis was performed before and after treatment by the "Pour Plate" technique. The non-ionizing irradiation of the microwaves in the tested furnace is able to totally eliminate the CFU/g of the microorganisms present in the organic sludge from poultry slaughterhouse at 220°C, it is showing process efficiency.

Keywords: Organic Waste; ONDATEC® Technology; Pour Plate Technique.

RESUMO

A inativação microbiana em resíduos orgânicos é necessária para evitar danos ambientais com impactos na vegetação e nos organismos do solo. O objetivo desta pesquisa é processar o lodo orgânico de efluentes de carnes de aves em forno de microondas, visando a inativação microbiana para seu uso como fertilizante orgânico. O lodo, previamente seco ao ar livre, foi submetido à ação de microondas no forno de cavidade rotativa, tecnologia ONDATEC®, a diferentes temperaturas e tempo de exposição. A análise microbiológica foi realizada antes e após o tratamento pela técnica "Pour Plate". A irradiação não ionizante das microondas no forno testado é capaz de eliminar totalmente a UFC / g dos microrganismos presentes no lodo orgânico do matadouro de aves a 220°C, demonstrando eficiência do processo.

Palavras-chave: Resíduos Orgânicos; Tecnologia ONDATEC®; Técnica "Pour Plate".

1. INTRODUÇÃO

Microbial inactivation in organic waste is justified because the deposit of organic and organometallic compounds generated by human action, such as tannery sludge, it is sources of soil contamination, through increasing the microbial load that can reach concentrations capable of causing environmental damage with impacts on vegetation and soil organisms (Passianoto et al., 2001). The action of microwaves is cited as a method capable of eliminating microorganisms from waste containing organic compounds, it is making them suitable for disposal in the soil, the treated material (Diaz et al., 2005; Brasil, 2006).

The rotative cavity microwave oven, ONDATEC® technology, it has been tested to decrease the microbial load of other wastes. The health service waste treatment (HSW) using this technology, proved to be efficient in inactivating microorganisms in HSW to the acceptable limit by Brazilian Health Regulatory Agency (ANVISA), it is leading to disinfection of the waste and framing it as uncontaminated waste (Bucek et al., 2016; Brasil, 2006).

The objective of this research is process the organic sludge from poultry meats effluents in a microwave oven, ONDATEC® technology, and evaluates the microbial inactivation

capacity, allowing the use of the sludge treated, as organic fertilizer according to the legislation. This study has as future perspective the reduction of residues stocke in slaughterhouses and contribute to the sustainability and preservation of the environment and sanitary.

2. MATERIALS AND METHODS

The rotative cavity microwave oven, ONDATEC® technology, it has the following characteristics power: 20 kW; supply voltage 220V 60 Hz; 650 L hex cavity with adjustable rotation per frequency inverter (30 to 60 Hz); 24 magnetron valves with manual control and individual power; with a reactor; with an exhaust gas separation system.

The sludge was previously dry at open-air, by solar heating (minimum 4 days), which was potentiated by the galvanized steel plates in which the sludge was deposited, until firm consistency, eliminating the maximum moisture present in this residue, followed by homogenization. Then, the material (25 kg/treatment) was processed at different temperatures and time of exposure to microwave action.

Microbiological analysis (Silva et al., 2010) was performed before and after treatment by deep sowing Technique Pour Plate. The samples collections happened inside the material containment basket, located inside the revolving cavity, in sterile collection bags (50g), under refrigeration (+ 4° C). After incubate 1 g of sample in 9 ml Brain Health Infusion Broth (BHI) at 37°C for 24 hours, followed by dilution in saline until obtaining countable colonies (10-1 to 10-10 v/v). Dilutions were plated on Nutrient Agar (NA) and Potate Dextrose Agar (PDA) to quantify bacteria and fungi. Subsequently, the plates were incubated at 37°C for 24 to 48 h, followed by counting of colony forming units (CFU/g). Analyzes were done in triplicate (n=3).

3. RESULTS AND DISCUSSION

According to the behavior of the residue throughout the treatment, the organic sludge allowed the temperature variation from 100°C to 525°C, without its carbonization in the pyrolysis process. Pyrolysis occurred at temperatures above 100°C. The open-air prior treatment that eliminated excess moisture from the organic sludge allowed the pyrolysis to be accelerated by microwaves, since the pyrolysis occurred after 100°C, according to the drying curves obtained, in Figure 1.

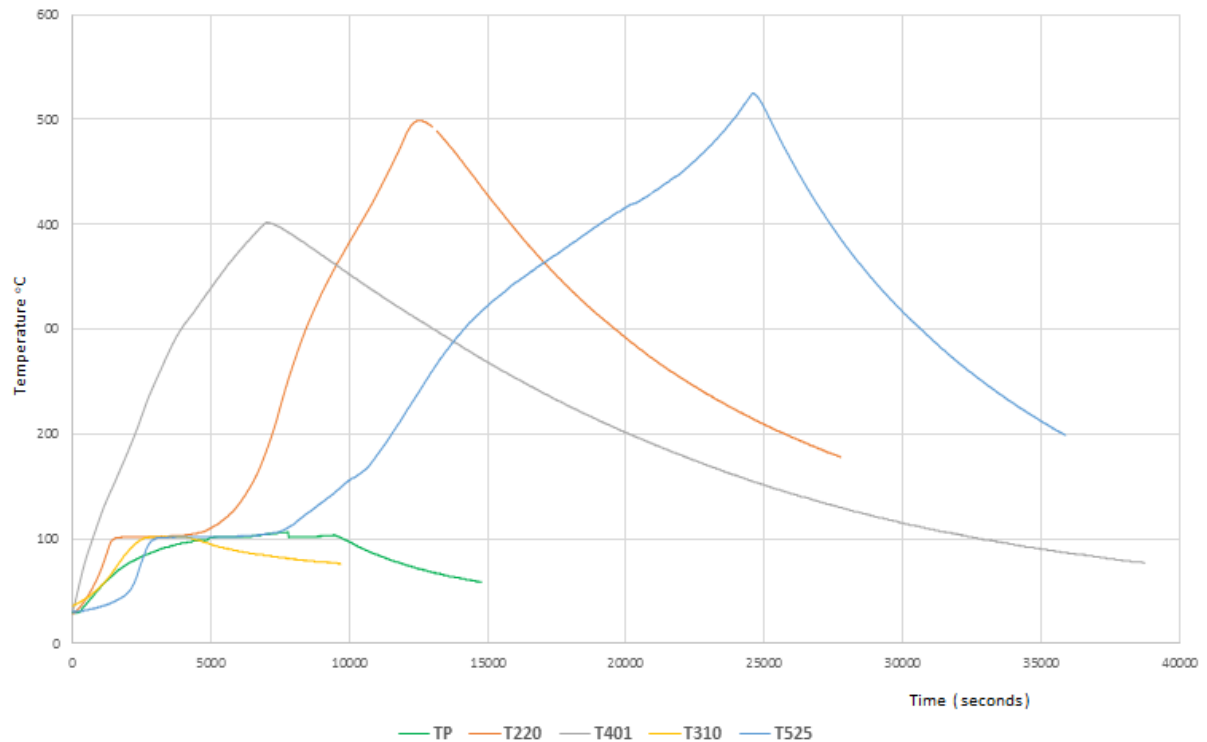


Figure 1 – Treatment of organic sludge at different temperatures in the microwave oven, ONDATEC® Technology, as a function of time.

The open-air prior treatment that eliminated excess moisture from the organic sludge allowed the pyrolysis to be accelerated by microwaves, since the pyrolysis occurred after 100°C, according to the drying curves obtained (Figure 1). The variation of the sludge residence time at 100°C in the oven in different tests is, as expected, due to the variation of moisture in the treatment process (open-air drying) as it is a procedure with high response variation, but applied, because it has a low cost, procedure applied in practice by companies. Despite the homogenization of the sludge after drying in the open-air, the presence of lumps, justifies this variation of moisture.

The maximum temperatures that defined each organic sludge pyrolysis process were: 220°C, 401°C, 500°C and 525°C. Microwave treatment at a maximum temperature of 220°C was sufficient to eliminate all microorganisms. This reduction was from 1 to 5 x 10⁷ CFU/g (open-air pretreatment sample) to zero CFU/g, as shown in Table 1. The pyrolysis time in this assay was 1:40 h and sampling for microbiological analysis was performed inside the oven immediately after opening the cavity (shortly after cooling off at the end of treatment).

TABLE 1- Microbial load analysis of organic sludge before and after treatment at 220°C in microwave oven, ONDATEC® Technology.

Organic Sludge	Microbial Load (CFU/g)		
	n1*	n2*	n3*
open-air pretreatment	1 x 10 ⁷	5 x 10 ⁷	2 x 10 ⁷
Microwave treatment at 220° C	It did not grow	It did not grow	It did not grow

* n1, n2 e n3 – analyses repetitions

The principle of microwave action is by indirect heat source, where the magnetron, by radiating the electromagnetic waves, increases the degree of agitation of the molecules by the resonance process, resulting in heat dissipation (Diaz et al., 2005). This action on microorganisms is related to the type and composition of the material to be treated, which also determines the operating conditions of the oven. The influence of waste type on oven processing conditions can be confirmed by the health service waste treatment (HSW), at rotative cavity microwave oven, ONDATEC® technology. The reduction of the microbial HSW load to 10⁶ CFU/g (acceptable limit by ANVISA), as well as the total elimination of microorganisms from this residue, was around 86 °C, independent of the microwave exposure time and dependent on the high variation of the initial of HSW contamination leading to its disinfection (Bucek et al., 2016; Brasil, 2006).

4. CONCLUSION

Non-ionizing irradiation emitted by microwaves at rotative cavity microwave oven, ONDATEC® technology, it is capable of inactivating microorganisms present in organic sludge from poultry slaughterhouse. The process using the microwaves with the tested technology is efficient, promoting the disinfection of residue.

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