

Manures base on *Oreochromis niloticus* L. for agricultural use

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ABSTRACT

Objective: *Oreochromis niloticus* (Tilapia) meal was evaluated as a source of nutrients in agriculture, through a composting process mixed with a zero tillage soil.

Design/methodology/approach: Two manures were formulated, mixing flour and soil at a 30:70 ratio (mass/mass w:w) respectively. Compost A was maintained at 60 days of composting (ddc), compost B at 30 days. The phytotoxicity of the manures was evaluated as percentage of germination in *Solanum lycopersicum* (tomato) seeds.

Results: The N-P-K ratio (% dry mass) was 1.90-2.06-0.30 for manure A (60 ddc), and 2.60-2.24-0.34 for B (30 ddc). On germination, 100% concentration; manure A had 44.9% and B 19.6%, compared to the control. For concentration of 10% it was 93.7 and 111.4%, manure A and B, respectively.

Limitations on study/implications: It is necessary to carry out more phytotoxicity tests. In this experiment, dilutions were made in the manures to increase germination.

Findings/conclusions: The use of manure based on tilapia meal in agriculture is proposed in the future and in this way take advantage of the waste from fish processing.

Keywords: Fish meal, compost, tomato, soil improver

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INTRODUCTION

The fishing industry generates by-products, which will eventually become waste (Caruso *et al.*, 2016). Approximately 60% of them, are constituted by the skeleton, bones, viscera, scales, in recent research it has been proposed to use fishmeal in agriculture and benefits have been obtained in crop yield, nutritional improvement, resistance to salinity, improvement in soil properties, among others (Radziemska *et al.*, 2019; Yusel *et al.*, 2017). As another alternative in addition to its use, it is included in balanced feed. Given the current needs of sustainability, it is pertinent to conduct experiments where the use of fishmeal as organic fertilizer is introduced in crops of commercial and nutritional interest (Ruíz *et al.*, 2018), since these represent an alternative to the dependence on fertilizers of industrial origin in agriculture. The objective of the present research work was to elaborate

two fertilizers based on *Oreochromis niloticus* (tilapia), fishmeal and evaluate their effects on the development and phytotoxicity on *Solanum lycopersicum* L. (tomato) seed, for their potential agricultural use.

MATERIALS AND MÉTHODS

Soil and flour characterization

A no-till soil, without stubble, from the facilities of the Instituto Tecnológico de Tuxtla Gutiérrez (ITTG) (L. N. 16.756; L. W. 93.172) was used. *O. niloticus* meal was used. The physicochemical and macronutrient parameters evaluated for the meal and soil, as well as the methods are shown in (Table 1), where the results corresponding to the physicochemical characterization of the soil, meal and fertilizers evaluated in the present work are illustrated. The macronutrient content of *O. niloticus* meal in the present study was similar to that reported for species of commercial interest such as *Salmo salar* (salmon) and *Clupea arengus* (Herring) (Ahuja *et al.*, 2020).

Preparation and characterization of the fertilizers

Two fertilizers were formulated, mixing flour and soil at a 30: 70 ratio (mass/mass w:w) respectively. Compost A was kept at 60 days of composting (ddc) and compost B at 30 (ddc), keeping the mixtures at 60% relative humidity and turning three times a week, temperature and pH were also monitored. The physicochemical parameters determined in the compost and their methods are shown in (Table 1).

Table 1. Physicochemical characteristics: soil flour and fertilizers.

Method	Parameter	Soil	Flour	Fertilizer A	Fertilizer B	Unit
	Humidity	11.4±0.8	8.5±0.7	16±0.8	12±0.4	%
Gravimetric	Cap. de Retention of water (CRA)	69.9±1.16	113.5±5.1	72.5±7.2	88.9±8.3	
Potenciometer	pH	7.9±0.05	5.8±0.02	8.1±0.06	7.9±0.04	(dS/m)
	Electrical conductivity	0.74±0.01	4.2±0.06	3.00±0.01	3.10±0.04	
Combustion	Organic carbon	19.1±0.64	25.3±1.8	8.36±0.58	9.89±0.60	g/kg
Kjeldahl	Total nitrogen	1.8±0.01	80.4±1.5	1.90±0.59	2.60±0.69	
X-ray scattering Spectrometry	Phosphorus	0.02±0.16	2.59±0.21	2.06±0.05	2.24±0.04	% dry weight
	Potassium	0.67±0.03	0.52±0.05	0.30±0.11	0.34±0.09	
	Sodium	0.17±0.02	0.29±0.03	0.16±0.09	0.19±0.05	
	Magnesium	1.62±0.04	0.16±0.05	0.91±0.09	0.94±0.03	
	Calcium	8.29±0.30	4.43±0.38	9.38±0.03	9.39±0.09	
Kononova & Belchikova/ Royal Decree 1110-1990	Humic acids	Not applied	Not applied	2.37	4.39	% /100 g dry weight
	Fuk Fulvic acids	Not applied	Not applied	2.96	4.03	
Ratio basis dry	C/N ratio	10.6	0.31	4.40	3.81	no unit

Fertilizers phytotoxicity

A stock solution was prepared for both fertilizers at a 1:3 (w:v) fertilizer/distilled water ratio. It was mixed vigorously and allowed to stand for 24 h. two concentrations were applied, at 100 and 10%, 5 ml was applied from each treatment to Petri dishes, where 100 tomato seeds were placed on two layers of filter paper to provide moisture (Selim *et al.*, 2012). Seeds of *S. lycopersicum* var. Río Grande, Crown Seeds brand™, lot 12154-4709 were used. Each treatment and a control (distilled water) were evaluated in triplicate and the toxicity of the fertilizers was determined by the percentage of germination six days after sowing.

With the following equation:

$$\% \text{ de relative germination} = \frac{\text{No. of germinated seeds in compost extract}}{\text{No. of germinated seeds in the control}} \times 100$$

A simple ANOVA was applied and a multiple range test (Least significant difference: LSD. $P \leq 0.05$) was performed to determine statistical significance, using Statgraphics Centurion XXVI.I software.

RESULTS AND DISCUSSION

In (Figures 1 and 2) the behavior of temperature and pH respectively, of the composting process for the composts are illustrated. Temperature higher than 55 °C were recorded for both composts, this is an indicator of microbial activity when using *O. niloticus* meal as substrate (Radziemska *et al.*, 2019). Acidification of the medium was observed between days 7-15 this is generally due to the presence of short-chain acids such as acetic and lactic. Foul odors were perceived during the composting process, this is an effect of the emission of volatile organic compounds, such as hydrogen sulfide (H₂S) and ammonium (NH₄) (Lin *et al.*, 2021) (Figures 3 y 4) illustrate the color changes in the compost.

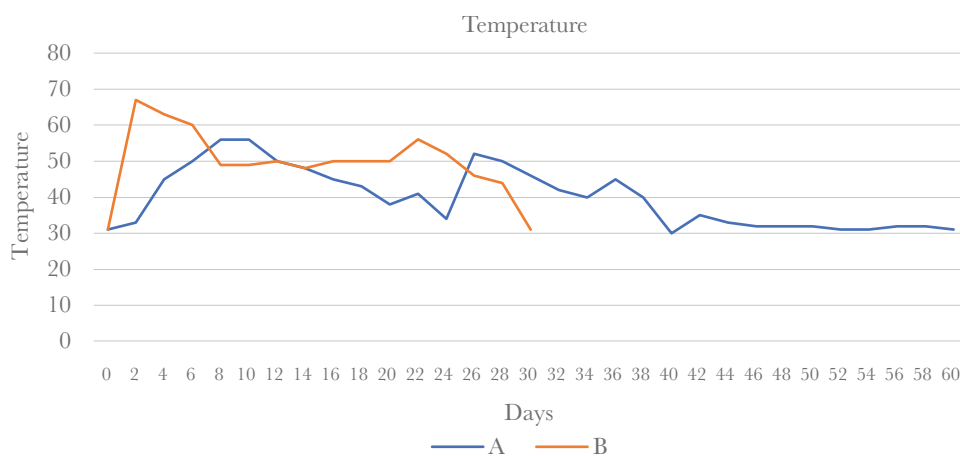


Figure 1. Behavior of temperature during composting.

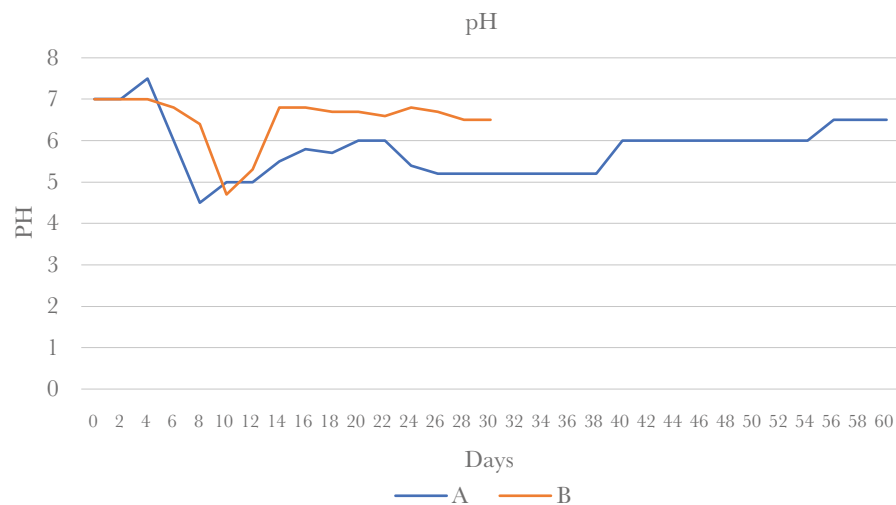


Figure 2. Behavior of pH during composting.



Figure 3. Changes in fertilizer A day 0 to day 60.



Figure 4. Changes in fertilizer B day 0 to day 30.

(Table 1) shows the results corresponding to the physicochemical characterization of the soil, meal and fertilizers evaluated in this study.

The N-P-K ratio (% dry mass) was 1.90-2.06-0.30 Fertilizer A, and 2.60-2.24-0.34 for B. According to (Palaniveloo, 2020), some expected characteristics in stable manures are as follows: 5.5-9.0 (pH), 50-60% (humedad), 43-65 °C (temperatura) and 25:1-30:1 (C/N ratio), very similar to those obtained by vermicomposting (NMX-FF-109-SCFI-2007), these parameters may vary due to the nature of the materials used in its formulation. (Figure 5) shows photographs of the phytotoxicity test.

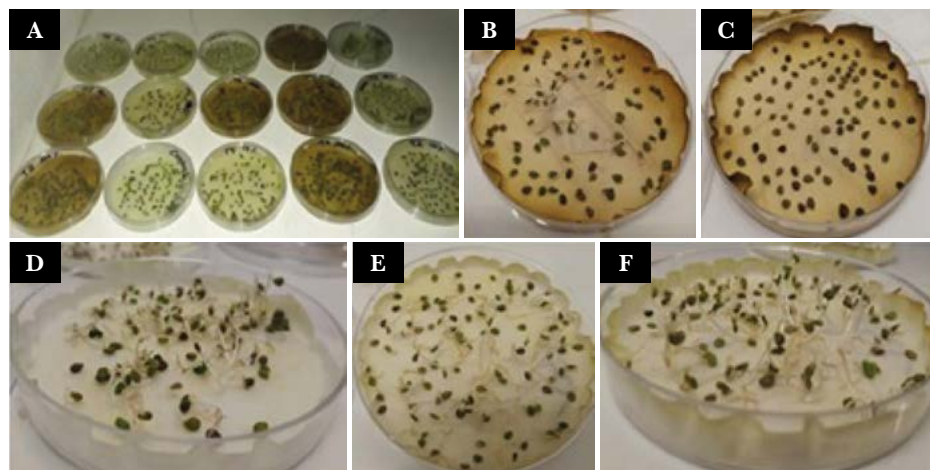


Figura 5. Phytotoxicity test of fertilizers based on *O. niloticus* meal. A) Treatments. B) Fertilizer A 100%. C) Fertilizer B 100%. D) Control. E) Fertilizer A 10%. F) Fertilizer B 10%.

Phytotoxicity symptoms were greater at 100% concentrations of fertilizer A and B, although there was germination, it was significantly lower than the 10% concentrations and the control. (Table 2 and 3) illustrate the ANOVA results and the effects of fertilizers on tomato seed germination, respectively.

Compost A (100%) exceeded the germination percentage of compost B (100%), due to the short composting period of the latter. The presence of phenolic compounds, ethylene and ammonium, excess accumulation of salts and organic acids is common in young compost and these substances can delay seed germination and even plant growth (Selim *et al.*, 2012). This effect was not the same when decreasing the concentration in Fertilizer B (10%), which presented significant statistical difference compared to fertilizers A and B at 100%, and even surpassing the control in relative germination by 111.4%. The phytotoxicity of

Table 2. ANOVA on the germination *Solanum lycopersicum* seeds.

Source	Sum of squares	Mean square	F-Ratio	P-Value
Entre grupos	5211.60	1303.90	4.09	0.0321
Intra grupos	3185.33	318.53		

Table 3. Effect of fertilizers on germination of *Solanum lycopersicum* seeds.

Fertilizers	Germinated seeds*	Relative germination
Fertilizer A (100%)	23.66±7.50 bc	44.9 %
Fertilizer B (100%)	10.33±9.60 c	19.6 %
Fertilizer A (10%)	49.33±26.08 ab	93.7 %
Fertilizer B (10%)	58.66±20.13 a	111.4 %
Control	52.66±18.92 ab	100 %

* Mean of germinated seeds followed by their standard deviation are indicated. Means with different groups of letters in the same column indicate significant differences, significant difference test (LSD) ($P \leq 0.05$).

the fertilizers according to % germination is reported as follows: <50% highly toxic; 50-80% moderately toxic; >80% shows no toxicity (Muñoz *et al.*, 2015).

CONCLUSIONS

Stability is an important quality parameter in composts, and is referred to the absence of plant or animal pathogens, as well as phytotoxic compounds. Stability is associated with the microbial activity in the compost and the composting time of the compost. The composts were categorized as moderately toxic (compost a 60 ddc) and highly toxic (Compost B 30 ddc) at 100% concentration, but with no phytotoxic effects at 10 % concentrations.

Fertilizer B showed statically significant difference over Fertilizer A and B at 100%, and even surpassed the control in germination percentage.

These results indicate that fertilizers based on *O. niloticus* meal can be elaborated and be a prospect for its application in the cultivation of *S. lycopersicum*, and in agriculture in general, at the same time reducing and taking advantage of the residues of the fishing industry.

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