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Quantification of Cu, Fe, Zn, and Mo in poultry manure generated in pre rains, rains and post rains

Cuantificación de Cu, Fe, Zn y Mo en pollinaza generada en pre lluvias, en lluvias y post lluvias

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RESUMEN

La pollinaza es la excreta de los pollos de engorda. La industria avícola mexicana genera grandes volúmenes de pollinaza, mayormente utilizada como fertilizante y alimento para ganado. En México se producen 1.2 millones de toneladas. Es común que tenga cobre (Cu), calcio, fósforo, sodio, potasio, magnesio, manganeso, molibdeno (Mo), fierro (Fe) y zinc (Zn) en este producto. Estos minerales pueden ser útiles, pero también dañinos según sea el caso, por lo que el objetivo es cuantificar los minerales Cu, Fe, Zn y Mo en la pollinaza en periodo de lluvias, antes y después de lluvias. Por cada periodo se analizaron 10 repeticiones. Las muestras provenían de diferentes casetas avícolas y fueron tomadas en el centro de acopio de pollinaza. Se determinaron las concentraciones de Cu, Fe, Zn y Mo en pollinaza en el Laboratorio de análisis de suelos mediante espectrofotometría de absorción atómica. Los niveles de pollinaza de cobre son mayores en lluvias que en periodo sin lluvias y por el contrario los niveles de hierro. Los niveles de zinc y molibdeno son iguales en lluvias y sin lluvias.

Palabras clave: minerales, tóxico, pollos, excremento.

ABSTRACT

The poultry manure is the excreta of the fattening chickens. The Mexican poultry industry generates 1.2 million tons of poultry manure used as fertilizer and for livestock feed. It is very common that it has copper (Cu), calcium (Ca), phosphorus (P), sodium (Na), potassium (K), magnesium (Mg), manganese (Mn), molybdenum (Mo), iron (Fe) and zinc (Zn). These minerals can be useful, but also harmful as the case may be, so the objective of this work is to quantify Cu, Fe, Zn, and Mo in poultry manure before, during and after the rainy season. For each period, 10 repetitions were analyzed and samples were taken from different poultry houses. Cu, Fe, Zn and Mo concentration in poultry manure were determined at the Soil Analysis Laboratory by atomic absorption spectrophotometry. Copper levels during the rainy season were higher than in the period without rain, and conversely to the iron levels. Zinc and molybdenum levels were equal during the rainy season and without rain.

Keywords: minerals, toxic, chickens, feces.

INTRODUCTION

The poultry manure is the excreta of broilers is always mixed with food residues, peeled intestinal mucosa, glandular secretions, microorganisms of the intestinal biota, mineral salts, feathers, insects, pigments, traces of medication and material used as a bed. The chemical composition varies according to the type of bed for chickens (wood shavings or sawdust, rice husk or soybean, ground cornmeal, ground wheat straw, oatmeal or sorghum, coffee bean husk, strip paper or leaves), floor and trough used, the number of litters, the ratio of bed volume and number of animals, the aging of the manure, humidity, etc. Other poultry excreta is the chicken manure, which are the laying of laying hens. Chicken manure is an excellent fertilizer, it superior effect being calculated to other fertilizers of animal origin (El sitio avícola, 2011).

The Mexican poultry industry generates large volumes of poultry manure mostly used as fertilizer and livestock feed. However, its inadequate management in the farms is reflected in an abnormal increase in the formation of ammonia, pH changes and high formation of pathogenic microorganisms that allow the presence of infectious and contagious diseases, to the detriment of the productivity and health programs of the companies (Antillón *et al*., 2011). The poultry manure is mostly used as a soil fertilizer and livestock feed (National Academy of Sciences, 1983; Cabrera-Núñez *et al*., 2018), and its demand is variable according to the season of the year. Demand is higher in the dry season due to the shortage of pastures, and for its use as fertilizer in the preparation of land for cultivation, and the demand decreases in the rainy season. Finally, it has a very limited use in the preparation of composts. The use of poultry manure as food in livestock is not allowed in the USA, Europe and other countries and it should be noted

In Mexico, the chicken is marketed at the foot of the farm, or in large deposits to which buyers come to transport it to the centers of consumption. Volumes of 200 to 300 g of dry matter are estimated per kg of feed, or 700 to 800 g of dry matter per chicken produced; or, 550 g of dry matter per kg of chicken, and finally 9.6 ton of dry matter per 1000 Kg of meat (García, 2008). This last figure would represent an estimated 1.2 million tons produced annually by 1,461 million chickens (UNA, 2008).

The producers of Hass avocado from Nayarit use the chicken manure as a fertilizer in addition to mineral fertilization, which is applied one to two months prior to the rains. The maximum fruit yield with the high dose fertilization treatment was obtained, which consisted of the application per tree of 2,140 kg N, 0.742 kg P_2O_5, 2.520 kg K_2O, 810 g Zn and 94.30 g B. Its equivalent for a garden with 156 trees per hectare, was: 333.84 kg N, 115,752 kg P_2O_5, 393.12 kg K_2O 126.36 kg Zn and 14,711 kg B), and resulted in an average yield for three years (2003 to 2005) of 28,197 t ha $^{-1}$ (Salazar *et al* ., 2009). Simon (2016) when studying the levels of fertilization with chickpea and its effect on the agronomic characteristics of the *Bracchiaria rusizenzi* grass, concluded that the agronomic characteristics are influenced by the organic fertilizer of the poultry manure,

according to the dose used; the most representative being the dose of 40 t ha^{-1} (4 kg/m^2) and that of 30 t ha^{-1} (3 kg/m^2).

The composition of the poultry manure is very variable, depending on the management of the poultry establishment; such as the number of aging and frequency and intensity of bed renewal. Its chemical composition is: 2.02% P, 2.88% N total, 4.49% Ca, 71.72% MO, 7.66 pH, 1.55% K and 1.19% S (De Battista y Arias, 2016). Organic bovine, goat and chicken manure contain 1.8, 2.0 and 2.8% of Nitrogen; 0.14, 0.14 and 0.90% of Phosphorus and 2.5, 2.4 and 5.2% of Calcium, correspondingly (López et al., 2001).

It is important to comment that organic fertilizers have been used since ancient times and their influence on soil fertility has been demonstrated, although their chemical composition, the contribution of nutrients to crops and their effect on the soil vary according to their origin, age , management and moisture content (Romero *et al*., 2000). In addition, the value of the organic matter it contains offers great advantages that can hardly be achieved with inorganic fertilizers (Castellanos, 1980). Hutton (1979), comments that a frequent problem in the improvement of grasslands in the tropical regions of Latin America, is the correction of soil deficiencies and that this affects the growth of legumes and grasses. Most of the acid soils in these regions are deficient in N, P, S, Ca, Mo and Zn and have minimum levels of K and Cu, and sometimes Mg.

It is common to find nitrogen, copper, calcium, phosphorus, sodium, potassium, magnesium, manganese, iron, molybdenum, zinc and occasionally cadmium and arsenic in the chickpea; with the consequent contamination of groundwater, reservoirs of surface waters and soils (Garcia *et al*., 2008). It also contains a large number of microorganisms (CFU/g): 130 x 105 aerobic mesophiles; 720 total coliforms and 550 fecal coliforms, which could be of benefit to agriculture or harmful (Castellanos *et al*; 2000; El sitio avícola, 2011). Some authors even recommend disinfecting it before using it as a fertilizer in agriculture, in order to avoid environmental pollution. There are also investigations that indicate chemical differences in the rainy season and without rains.

These minerals can be useful, but also harmful as the case may be, so the objective is to quantify the copper, iron, zinc and molybdenum minerals in the chick in the rainy season, before and after rains.

MATERIAL AND METHODS

The poultry manure study, generated by a company in Nayarit, Mexico, where the warm sub humid climate predominates, with rains in summer; average annual temperature of 21.3 ºC, average rainfall of 1152.3 mm and altitude of 915 m above sea level (INEGI, 2006).

The poultry manure production is year-round; however, only three periods were studied: pre rains, rains and post rains. This is important, since the use of chemical compounds in the treatment, control of poultry diseases and disinfection of facilities may vary depending

on the period; find residues of antibiotics, furans, arsenicals, disinfectants, coccidiostats and others (National Academy of Sciences, 1983).

For each period, 10 repetitions were analyzed; the samples came from different poultry houses and were taken at the chicken collection center. The concentrations of Cu, Fe, Zn and Mo in chickweed of the fresh-based samples were determined in the Soil Analysis Laboratory of the Academic Unit of Agriculture of the Autonomous University of Nayarit, by means of atomic absorption spectrophotometry, using a Spectra equipment AA from Varian Brand. The acids used were nitric acid with perchloric acid and reactive grade in a 2: 1 ratio (vol: vol) (Alcántar and Sandoval, 1999).

The excreta was handled following the indications of the Official Mexican Standard (NOM-044-ZOO-1995). The data were analyzed using an analysis of variance. These analyzes were performed with the STATISTIC statistical package see 4.5 (1993).

RESULTS AND DISCUSSION

The poultry manure can be purchased at the collection centers, at a price per kg of 0.5 and 1.2 Mexican pesos, with a humidity of 26.0±7.9%; while the chicken manure is cheaper, with greater humidity and microorganisms (Castellanos *et al*., 2000). The humidity of the chicken manure can be between 40 and 50%, at about 25 ºC of ambient temperature (Galarza, 2005).

The minerals in the poultry manure, showed higher levels of copper for the rainy season, compared with the previous season and the time after them (Table 1; $p<0.05$). Trend that coincides with that reported by Pacheco *et al*., 2003; however, the levels determined in this work are only 5.78 ppm for rains, 0.406 for pre rains and 0.498 for post rains. While Pacheco *et al*. Reports average 82.0 ppm. During the rains on poultry farms it is possible to increase the doses of chemical compounds, especially copper sulfate for disease control, so there is an increase in copper.

In contrast, zinc levels were not different for chicks sampled in the three seasons (table 1; $p> 0.05$). With 35.14±7.10 ppm, for pre-rain sampling, 40.75±8.60 ppm for rains and 48.26±7.74 ppm for post-rains sampling. These levels are clearly lower than those reported for chicks analyzed in Yucatán, where the levels averaged 289 ppm and a range of 120 - 546 ppm (Pacheco et al., 2003).

En contraste, los niveles de zinc no fueron diferentes para las pollinazas muestreadas en las tres épocas (cuadro 1; $p>0.05$). Con 35.14 ± 7.10 ppm, para el muestreo previo a lluvias, 40.75 ± 8.60 ppm para lluvias y 48.26 ± 7.74 ppm para el muestreo posterior a las lluvias. Dichos niveles son claramente inferiores a los informados para pollinazas analizadas en Yucatán, donde los niveles promediaron 289 ppm y un rango de 120 - 546 ppm (Pacheco *et al*., 2003).

Table 1. Mineral levels manure (ppm, fresh base)

Season	Cu mg L^{-1}	Zn mg L^{-1}	Fe mg L^{-1}	Mo mg L^{-1}
Pre rains	0.406±0.42[a]	35.14±7.10[a]	164.7±144[b]	333.6±80.0[a]
Rains	5.786±0.54[b]	40.75±8.60[a]	49.72±9.14[a]	282.3±142[a]
Post rains	0.498±0.36[a]	48.26±7.74[a]	321.04±183[b]	307.9±107[a]

Values are expressed as means ± standard deviations. a, b Different literals, indicate significant differences between epochs; p<0.05. Cu = Copper. Zn = Zinc. Fe = Iron. Mo = Molybdenum

On the other hand, iron levels were lower in chicks sampled in the rainy season 49.7 ± 9.14 ppm (p <0.05), than those of the previous season (164.7 ± 144 ppm) and the post-rainy season (321.04 ± 183 ppm). However, these values are lower than those determined by Pacheco *et al*., 2003, which report an average of 673 and a range between 359-1418 ppm in sampled chicks.

Poultry manure and slurry contain high concentrations of copper, zinc and molybdenum; this is due to the addition of copper in the diets for poultry and pigs as a growth promoter, as well as for disease control (Christie and Beattie, 1989). The problem stems from the fact that the amounts of these trace elements in the diet are not adjusted to the animal's requirements according to their productive status, and that is when they pass into the excrement (Vilafranca, 1997; Poulsen, 1998).

The poultry manure contains 3.15% of total nitrogen and Cu, Fe and Zn in ppm 52.4, 2200.8 and 575.2; pointing out that the three values are higher than the ones found in the pollinaza of this investigation. The cuyinaza also attracts attention (Cuy droppings) that contains 7255.5 ppm Fe, 31 ppm Cu, also has 15.08 Kg/T of nitrogen (Aliaga *et al*., 2009; Guamán, 2010).

CONCLUSION

The levels of copper in the poultry manure are higher in the rainy season than in the rainless period, and on the contrary the iron levels. The levels of zinc and molybdenum are equal in rains and without rains.

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