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Distribution of Iron, Manganese from Meat Products to Soil Caused by Feed Additives

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Abstract

The purpose of this paper was to determine the content of iron, manganese elements in feed additives, organs in the pig and chicken, and soil. The results showed that the diet supplemented with heavy metal, part of the meat and liver accumulation, most of the other with feces excreted. In this paper, an adsorption model was established, and fitted the adsorption coefficient and transfer coefficient of iron, manganese. The reliability is more than 95%, the relative errors are within 0.5%.

Keywords: ***Feed, Meat products; Iron, Manganese; Non-linearity simulation; Adsorption model***

Introduction

The meat products are very significant for livestock because the trace elements of domestic animals are the key to the health of human body [1]. In order to prevent diseases and promote animal growth, a lot of metals are added into feed excessively [2].

The iron (Fe) with rapid growth in the early stage of life requirement of neonatal piglets' increases. Nursing pigs require 7 mg to 16 mg of Fe daily to support metabolic activities [3]. The young pig of its body stores uses 40 mg to 50 mg Fe that was transferred during gestation, but these supplies become inadequate within 7 d to 10 d of age [4-5].

Manganese (Mn) for animals is an essential trace element, and the need is quite high for this element of poultry. Manganese such as phosphatase, choline esterase, alkaline phosphatase, esterase, enzyme, ATP and so on, is an activator of many enzymes. Now, the study has found that manganese of galactose transferase, polysaccharide polymerase, RNA dependent

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DNA polymerase have activation. The activity of these which affected the growth and skeletal development of poultry enzymes decreased.

In this paper, the contents of heavy metals in the soil samples from the feed- organs- farm manure - different soil depths were determined, the contents of heavy metals in every link were measured by microwave digestion method. The migration model of iron and manganese content in different soil depth was established. The nonlinear simulation of the experimental data is carried out with the MATLAB 7.1 program, the adsorption constants and the promoting factors of iron and manganese in soil were obtained, and the contents of elements in different soil distribution were determined.

Experiments

Apparatus and materials

Atomic absorption spectrophotometer (AA-7000, Shimadzu, Japan); MARS microwave digestion (American CEM).

Excellent-grade reagents and deionized water were used along all the experiments. Iron and manganese standard solutions were diluted daily. The samples were all collected from Anshan of Liaoning Province. The determination optimal conditions are listed in Table 1.

TABLE. 1. **Optional operating conditions.**

Element	Wavelength (nm)	Lamp current (mA)	Bandwidth (mm)
Fe	248.3	12	0.2
Mn	285.2	8	0.7

Preparation of samples

Appropriate amount of feed, meat products, livers and manure were dried, milled and mixed, adding 5 ml nitric acid and 3 ml hydrogen peroxide, and temperature programmed to digest by the microwave digestion instrument. After cooling to room temperature, discharging acid residual was 1 ml to 2 ml in which water was added to make up the volume to 25 ml in the volumetric flask.

Results and Discussion

Feed and meat products determination

All samples calculated iron and manganese concentrations from dry materials are listed in Table 2.

TABLE. 2. **Determination of atomic fluorescence or atomic absorption of Fe and Mn (mg/kg).**

	Chicken feed	Pig feed	Chicken liver	Chicken	Pig liver	Pork	Chicken manure	Pig manure
Fe	82.4	120.1	614.7	13.5	930.9	71.2	1182.4	1021.0
Mn	21.9	34.7	2.84	0.41	4.21	0.7	235.3	207.2

Above results showed that iron and manganese are absorbed in a minor and the majorities are concentrated in manure.

Manganese with manure soil determination

The iron, manganese and water content concentrations are listed in Table 3.

TABLE. 3. **Fe, Mn (mg/kg) and water content (%) of different soil depths (cm).**

	0	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**
Fe (Without manure)	80.2	73.4	70.7	63.8	61.5	58.8	56.7	54.9	53.5
Fe (With manure)	213.6	195.8	188.4	170.2	163.9	156.8	150.9	146.2	142.5
Mn (Without manure)	31.2	30.2	29.1	28.5	27.9	27.4	26.9	26.5	26.2
Mn (With manure)	89.2	86.1	83.6	81.5	79.9	78.4	77.0	75.8	75.0
Water content	12.5	13.3	14.1	15.1	16.0	16.9	17.6	18.5	19.6

The concentrations of iron and manganese in unapplied manure soil were obviously low comparing with applied manure soil. The concentrations of iron and manganese in soil as the depth were decreased.

Design and parameter fitting of iron and manganese in different soil depth

According to Langmuir adsorption model, considering the heavy metal contents in the soil with water downward migration, we design the migration model of the contents of heavy metals in different soil depth with the soil of different depth and different depth soil moisture was:

$$C = \frac{K_1 X}{X + K_2 L} \qquad (1)$$

C (mg/Kg) - concentration of a certain depth, K_1 - adsorption coefficient, K_2- transfer coefficient, X - water content, L (cm) - soil depth.

The fitting of MATLAB 7.1 is used to fit data and the original data to the corresponding point of the square and minimum error.

According to the experimental data of Table 3, it can be seen, in a certain range, water content and soil depth was linear. According to the experimental data of Fe element in Table 3, the estimated values of the parameters K_1 and K_2 are determined by trial calculations. K_1 was 213.8280, K_2 was 0.2445, The relative errors are within 0.5%, and the reliability is more than 0.95.

$$C = \frac{213.8280X}{X + 0.2445L} \qquad (2)$$

According to Table 3, the fitting model of As is obtained.

$$C\ (Mn) = \frac{89.0894X}{X + 0.0920L} \qquad (3)$$

In 27 cm soil, Fe and Mn concentrations are 155.2 mg/kg, 77.3 mg/kg, the experimental data is 154.5 mg/kg, 77.8 mg/kg, the experimental values are close to the calculated values, which indicates that the design model and the fitting parameters are ideal.

Conclusions

1. Iron and manganese are absorbed in a minor and the majorities are concentrated in manure.
2. The concentrations of iron and manganese in unapplied manure soil were obviously low comparing with applied manure soil. The concentrations of iron and manganese in soil as the depth were decreased.
3. The reliability is more than 95%, the relative errors are within 0.5%.

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