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Investigation of Iron Levels in Locally Prepared Livestock Feeds in Uganda

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Abstract

Due to lack of regulations and certifications in Uganda for iron levels in animal feeds, there is great variability in iron levels in feeds from different suppliers. This may lead to under or over dosages of iron in animal feeds which may result in reduced farm productivity. In this study, locally produced animal feeds namely broiler starter, dairy meal and sow and weaner from six different suppliers namely Biyinzika, Mutima, Impala, Kuku, Nuvita, and Ugachic were investigated for their iron levels. The iron levels were determined using the European Commission method for Iron and atomic absorption spectroscopy. Results indicate a substantial variation in iron levels recorded for the different suppliers ranging from 70 to 630 mg/kg. This was linked to insufficient knowledge and expertise in feed formulations and the lack of local regulatory standards for iron in animal feeds in Uganda. However, the results obtained in this study are within the limits set by international standards agencies and comparable to other studies.

Keywords: Iron levels; Diary meal; Broiler starter; Sow and weaner; Uganda

Introduction

Iron in the right quantities, is needed for cell constituent and enzyme synthesis in animals [1]. Animals need a balanced ration which is the amounts fed in 24 hours for cell growth, repair, gestation or lactation. Milk producing animals require mixed rations which include grains, forages, protein, vitamins, minerals (iron), and additives in the right mix [2]. In Uganda, there is lack of feed quality regulation and policy and that those involved in the business of mixing feed rations currently require no requirements such as certification to meet as a prerequisite to participate in the business. Most feed suppliers do not have the necessary technical skills to formulate and produce well balanced feed rations to meet the animal requirements. They instead rely on trial and error means of formulating the feeds with a risk of producing substandard feeds. Furthermore, feed quality is also affected by poor forms of transport especially for the raw materials, improper feed handling, poor storage conditions as well as feed quality deterioration during repackaging by traders. Farmers in-turn have resorted to making their own homemade feed formulations relying on experience in the field. All these factors have led to poor quality feeds on the market resulting in reduced farm yields [3].

In Uganda, Livestock production including poultry, diary, sheep, goats and pigs, contribute 1.7% to the total GDP [4]. In 2008, cattle were estimated to be 11.4 million whereas the goats sheep poultry, and, pigs were estimated at 8.5 million, 3.4 million, 27.5 million, and 3.2 million respectively. The main breeds of cattle kept are indigenous constituting 60% of the households 40% keep exotic/cross breeds. The increasing population means increased demand for eggs, milk and meat, hence, to enhance livestock productivity, farmers use supplements in feeds [5]. About 33% of the dairy farmers use nutrient enriched feed while nearly 56% use feed maize bran and rice bran as straights. Commercial feed millers produce about 75,000 tons annually wile small scale mixers produce 40,000 tons annually [3].

The National Research Council [6] has set maximum tolerable concentrations of dietary iron as 500 mg/kg for cattle, 500 mg/kg for sheep, 500 mg/kg for poultry, 3,000 mg/kg for swine, and 0.1 mg/L for aquatic animals and fish [6]. Iron poisoning occurs when excess iron is injected or given orally to the animal. Oral dosages greater than 150 mg/kg, body weight are considered excessive and may lead to iron poisoning and toxicity.

This study investigated iron levels in broiler starter, dairy meal and sow and weaner from six Ugandan local suppliers: Mutima Feeds limited, Ugachick Feeds limited, Impala Feeds limited, Kuku Feeds limited, Nuvita Feeds limited and Biyinzika Feed Suppliers limited. The obtained values were compared to other similar studies and international standards.

Material and Methods

The method for determination and quantification of Iron content for the different livestock feeds followed the European commission method for Iron based on dry ashing followed by acidic digestion of the feed stuff samples and then atomic absorption spectrophotometric (AAS) measurement.

One kilogram weight of each of the selected livestock feed samples packed in Low density polyethylene (LDPE) bags were bought from Mutima Feeds limited, Ugachick Feeds limited, Impala Feeds limited, Kuku Feeds limited, Nuvita Feeds limited and Biyinzika Feed Suppliers limited, all located in Kampala central business district. The samples were subjected to oven-drying at temperatures of 105°C for 24 hrs and later placed in a desiccator for cooling to prevent them from attracting moisture and then crushed using a sample grinder to convert them into powders. Approximately 4.0 g of a powdered feed sample was weighed into a dry and clean porcelain crucible and then placed into an electric furnace set at temperatures of 550°C which was slowly increased to 600°C and maintained for 8 hours. On removing the porcelain crucibles from the furnace, the powdered feed samples had turned into ash

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and placed in a desiccator for cooling. The carbon free ash residues were dissolved in 10 ml of 3 M hydrochloric acid and then diluted to a definite volume of 100 ml before being introduced in the atomic absorption spectrophotometer for Iron determination.

The Spectrophotometer used was a 6300 shimadzu, made in Japan, with Flame atomiser, graphite furnace atomiser, mercury vapour unit. It's a GFA-EX7i model, serial number A30534200187LP, and catalog number 206-52100-34. The instrumental conditions for the AAS (Atomic absorption Spectrophotometer, model: Shimadzu 6300 with a programmable auto sampler, desktop computer and printer data tape) were set at wavelength 248.3 nm, Lamp current value 2.0 mA, Slit width 0.7 mm and air/acetylene flow ratio 3.5/1.5.

Prior to sample determination, the AAS was subjected to a calibration with analytical standards (1000 µg/ml Fe^{3+}- plasma HIQU, density – 1.032 g/ml at 20°C, manufactured by Chem-Lab NV, Industriezone "De Arend"2, B-8210 Zedelgem, Belgium) of known concentration of Iron whose concentrations ranged from 0.2-4 ppm prepared from pure stock solution of 1000 ug/mL prepared serially and diluted with 1% nitric acid. These were used to obtain a calibration curve for iron with a linear regression coefficient (R^2) value of 0.9993. The samples were then aspirated into the AAS and the relative concentrations of iron in the samples were determined. The relative concentration of iron in each feed sample were determined as shown in Eqn. (1).

$$Fe\ (mg/kg) = (Cm \times Df \times Vd)/Wt \quad (1)$$

Where,

Fe - Iron concentration in mg/kg

Cm - Concentration of Iron as read by the AAS

Df - Dilution factor

Vd - Volume to which the sample has been diluted after ashing

Wt - Original weight of sample in grams.

Results

Broiler starter

The broiler starter Fe levels were in the range 68 to 540 mg/kg with Nuvita and Mutima feed suppliers having the highest concentrations of Fe in their feeds (Figure 1).

Dairy meal

The dairy meal Fe levels were in the range 67 to 453 mg/kg with Nuvita and Impala feed suppliers having the highest concentrations of Fe in their feeds (Figure 2).

Sow and weaner

The sow and weaner meal Fe levels were in the range 188 to 635 mg/kg with Kuku and Impala feed suppliers having the highest concentrations of Fe in their feeds (Table 1).

Discussion

The amount of Fe (mg/kg) detected in feeds varied considerably across the different suppliers from 187.6 ± 7.6 mg/kg to 635 ± 15.1 mg/kg. This variation can be attributed to the lack of sufficient technical knowledge and expertise in feed formulations and the lack of local regulatory standards for iron in Uganda. Iron requirement as a concentration of diet decreases with age and weight due to a decrease in blood volume per unit weight and higher iron intakes.

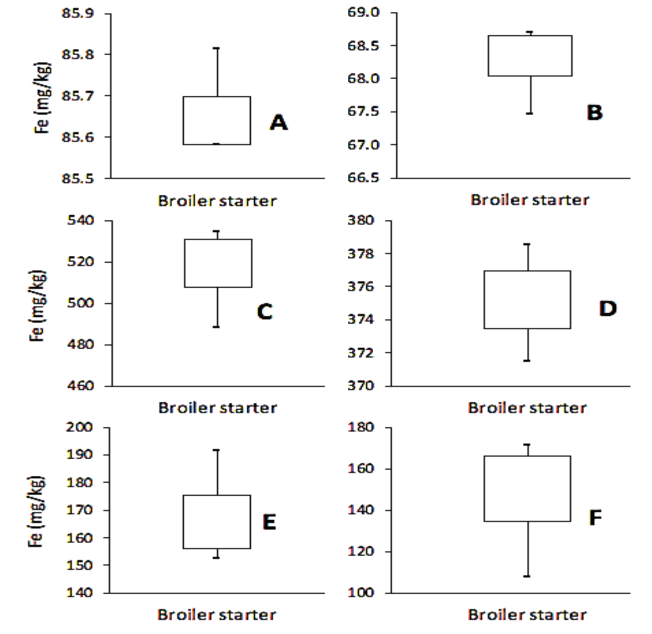

Figure 1: Iron levels recorded in broiler starter feeds from different suppliers: A - Ugachic; B - Biyinzika; C - Nuvita; D - Mutima; E - Kuku; F – Impala.

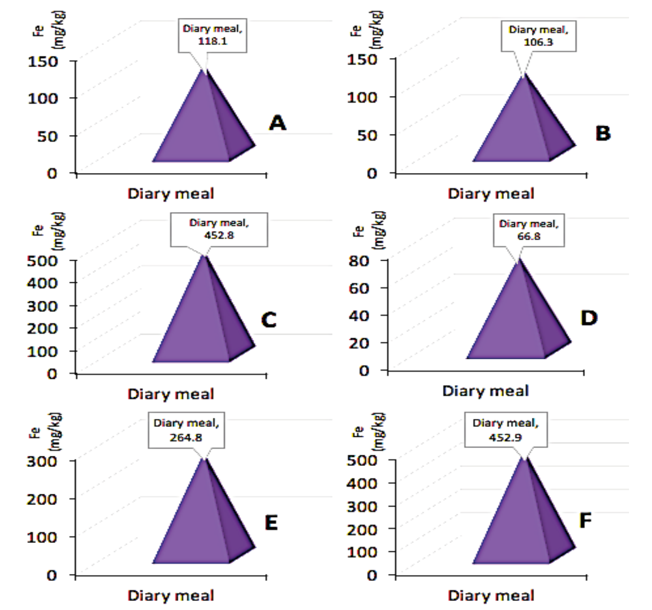

Figure 2: Iron levels recorded in dairy meal feeds from different suppliers: A - Ugachic; B - Biyinzika; C - Nuvita; D - Mutima; E - Kuku; F – Impala.

The iron requirements for pigs 1 to 5 and 20 to 50 kg live weight are 100 and 60 parts per million respectively, which is equivalent to iron intakes of 25 and 114 milligram [7]. Piglets require more (100 mg/kg), pigs and sow require less (80 mg/kg) [8]. The amounts detected in the feeds in this study were higher than the recommended amounts especially Nuvita, Kuku and Impala feeds. Wang et al. [9] observed that organic iron complex administered as 107 mg/kg had minor positive effects on the iron status of sows and nursing pigs, and did not improve the performance of sows and their offspring. They

Variables	Mean value (mg/kg)	[a]RSD	Reference
Mutima	376.6	3.8	This study
Ugachic	187.6	7.6	This study
Biyinzika	251.9	7.8	This study
Nuvita	467.8	47.2	This study
Kuku	546.2	13.6	This study
Impala	635.4	15.1	This study
Wang et al.	107	-	[9]
Novais et al.	551	-	[10]
Sorensen	750	-	[11]
Collins et al.	80	-	[19]
[a]RSD - Relative Standard Deviation			

Table 1: Iron levels detected in sow and weaner feeds from different suppliers. The values were computed with one standard deviation.

concluded that replacement of the commonly used Fe injection with a maternal organic iron complex dietary supplement failed to prevent iron-deficiency anemia of nursing pigs. Novais et al. [10] also observed that chelated iron supplementation was insufficient to meet piglet demand. Similarly, Sorensen [11] observed that replacing inorganic with organically bound Fe showed no biological effects in sows when their need for Fe was covered via their feed.

Broilers fed on pre-starter containing 100 mg/kg of Fe and starter, grower and finisher containing 70 mg/kg Fe [12] are all consistent with the feeds Fe levels in this study. In another study, 25 mg/kg Fe was supplied to broilers in addition to the main feeds [13]. As part of the mineral premix in the basal diet, 75 mg/kg of Fe was fed to broilers [14]. Akter et al. [15] investigated the effect of increased iron level in phytase-supplemented diets on performance and nutrient utilisation in broiler chickens. They administered 65- 110 mg/kg Fe. In another study, 100 mg/kg total Fe as $FeSO_4$: Fe-Glycine in different proportions was added to basal diets of broilers [16].

In the Midlands and North of England, the mineral concentrations in the diet of early lactation dairy cows fed during the winter of 2011-2012 on 50 herds were 315 mg/kg was fed [17], consistent with the levels found in this study. In another study, 1992 mg/kg Fe was detected in dairy feed, a concentration so high that it caused seventy cattle fatalities on one farm in Turkey [18,19].

The addition of organically bound micro minerals may increase sow productivity, longevity and claw health compared with micro minerals bound as salts. Fe in concentrations of 750 mg/kg complete diet maximum, and 100 mg/kg as standard additions to Danish sow feed was used [11]. The results obtained in this study are also comparable with the permissible levels of iron for the National Research Council [6].

Conclusion

In this study, the iron levels in selected animal feeds: dairy meal, broiler starter and sow and weaner from different suppliers in Uganda were investigated. Sow and weaner feeds generally had the highest iron concentrations followed by broiler starter while dairy meal had the least iron levels. There was a significant variation in iron level values recorded for the different suppliers. This was linked to insufficient knowledge and expertise in feed formulations and the lack of local regulatory standards for iron in Uganda. Local farmers need to follow strict guidelines for making their own feeds to avoid over/or under feeding livestock. In particular, established and recognised feed manufacturers should supply quality and affordable feeds. This will assist in minimising farmers making their own formulations.

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Conflict of Interest

We have no competing interests to declare.

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