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**Assessing Chromium (Cr) Burden in Organ of Hacco and Isa Brown Adult Chicken Layers  
(*Gallus spp.*) from Water, Drugs and Chicken Feeds**

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**Abstract**

*An assessment of chromium (Cr) contents in water, Layer Chicken feeds and drugs was conducted to examine the probable source of Cr burden in the organ of Adult Hacco and Isa Brown chicken layers sampled. Samples of water, drugs, feeds and organ of Adult Hacco and Isa Brown Chicken Layers were analysed by the standard analytical methods of inductively coupled plasma-optical emission spectrometry (ICP-OES) following wet digestion procedure. The results revealed that Cr profile in source materials indicated that its contribution to accumulation is largely dependent on the feed with an average concentration of 0.4166 mg/g constituting 77%, in Farm 1 (a). This is followed by drugs (22%) and water (1%). Thus, drug and water intake in this farm poses no accumulation risk. Therefore, the distribution of Cr in organs (Farm 1 b) is mainly sourced from the feed which was highest in gizzard by 47%. This trend is similar in Farm 2, but with a higher (81%) contribution from feed. Therefore, were drugs not administered, the poultry feed will remain the principal source.*

**Keywords:** Cr, distribution profile, Adult Chicken Layer organ, feed, water, drug

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**Introduction**

The commercial production of poultry animals either for their meat or eggs involves the use of basic raw materials ranging from poultry feeds, water and drugs. The raw materials, as a result, become the potential source of the intake of nutrients as well as toxicants for the animals. However, some mineral elements such as Fe, Mn, Cu and Zn are important dietary nutrients for livestock and poultry. Nevertheless, all mineral elements, whether considered to be essential or potentially toxic, can have a harmful effect upon humans and animals if included in the diet at excessively high concentrations (Okoye, 2011).

There are four major factors that affects the absorption of Cr in animals as enumerated by Morris (1987): “1) the age, chromium status and state of health of the animal, 2) conditions within the gastrointestinal tract; 3) the amount and chemical form of the chromium ingested; and 4) the amount and proportions of various other components of the diet, both organic and inorganic”.

In earlier studies (Iwegbue *et al.*, 2008, Mohammed *et al.*, 2013), It shows that gizzard of Hacco (0.691±0.042 mg/g) and Isa Brown (0.684±0.036 mg/g) form the respective Farm1 and Farm2 accumulated the highest in Cr concentrations, while liver organs were least, Liver1 (0.104±0.029

mg/g) and Liver2 (0.102±0.029 mg/g) from Farm1 and Farm2 respectively.

In the more recent study (Mohammed *et al.*, 2013) of four organ, the general order of Cr concentration in layer poultry organ studied is: gizzard > breast meat > liver > kidney.

The samples analysed were collected from two commercial Layer Chicken farms and it is unclear the most likely contributor of Cr concentration in the organ studied; whether the feeds, drugs or water. Therefore, this study is intended as a continuation to these earlier findings, as an assessment of Cr contents in these inevitable raw materials of commercial poultry production in comparison to the organ concentration, to enable understanding of the most burdensome source of Cr in the organs of chicken layers.

## **Materials and Methods**

### ***Chicken Layer Samples***

Isa brown and Black Hacco, both of Adult Chicken Layers (*Gallus spp*) were sampled for this study. 12 each of these adult layers making a total of 24-layer chickens were sampled in threefold over a period of 8 weeks. Sampling took place between the months of November 2012 and January 2013. The Adult Layer chickens' samples are products from two commercial chicken layers production farms respectively in North Eastern Nigeria.

The organ compared include breast meat, gizzard, liver and kidney. The four organ from the adult layer chickens were harvested according to standard veterinary protocols (OLAW, 2002). Expert supervision and contribution were received from a veterinary physician identified poultry species and performed the procedure. All cutting knives and forceps used are of sterile stainless-steel

materials. Thus, composite samples of three each of the organs collected from the respective farms were used for the analysis. Organ samples were collected in sterile polyethylene containers and transported to the laboratory for preparations and subsequent analysis.

### ***Layer Chicken feeds, Water and Drugs***

Two brands of the commercial feeds, hybrid and livestock utilized in feeding the adult layer chickens at the farms were sampled and analysed for Fe content. The feeds are locally produced in Nigeria. Samples of feeds were also collected at the respective farms simultaneously as the adult layer chicken organ. Homogenized composites (1 kg) were collected using plastic cups from feeds bags into a sterile polyethylene bag and transported to the laboratory for analysis.

Similarly drinking water administered to the animals was also collected in an interval of 4 days for five different sampling times, which constitute a total of 10 samples for the two farms. (Antibiotics, dietary supplements and vaccines) samples that are routinely administered to the adult layer chickens were also collected and analysed. The (antibiotics, dietary supplements and vaccines) samples are similar for both farms.

### ***Samples Preparations***

Samples preparations for organs, layer chicken feeds, water and drugs were conducted according to methods described in Belton (2006). Demineralized water was used to clean and wash the harvested. The organ were chopped into small sizeable pieces with stainless steel knife, after which they were oven dried at 65 °C for about 48 hours continuously until constant weight was ascertained.

The wet digestion procedure was used to prepare both organ and feeds samples. 2 g of the samples was placed in a digestion tube, pre-digested in 10 mL concentrated HNO<sub>3</sub> at 135 °C until the liquor was clear. Thereafter, 10 mL of HNO<sub>3</sub>, 1 mL HClO<sub>4</sub> and 2 mL H<sub>2</sub>O<sub>2</sub> was added and temperature was maintained at 135 °C for 1 h until the liquor became colourless. The product of the digestion was allowed to slowly evaporate to near dryness. This was then cooled and dissolved in 1 M HNO<sub>3</sub> and the digests subsequently filtered through Whatman filter No. 1 and diluted to 25 mL with 1 M HNO<sub>3</sub>.

#### ***Determinations of Cr***

The external standard method of Inductively Coupled Plasma – Optical Emission Spectrometry (ICP-OES) was used to determine Cr concentrations in the prepared samples (Boss and Fredeen, 1997; Agilent, 2010). A standard Cr curve as sought for analytes was prepared from stock solutions (standard concentrations of 1000 mg/ml) of metal analytes, which was to cover the optimum emission working range (0.01 to 5.00 mg/ml). Thus, further serial dilutions were made.

The determination was carried out at the Central Laboratory of Geology Department

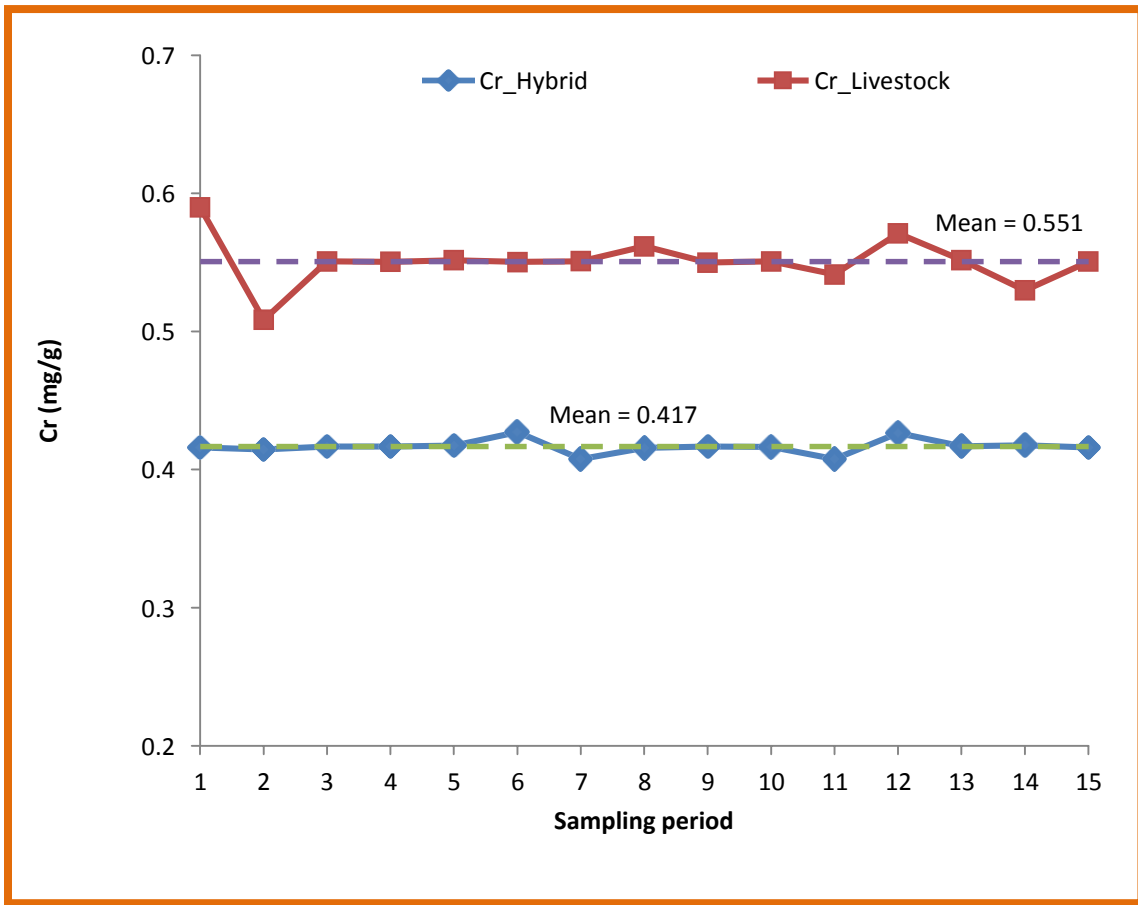
University of Maiduguri, Borno State, Nigeria. The analysis portion of the samples were conducted through an Agilent ICP-OES (USA) instrument model 710 series, coupled with an SPS auto-sampler determined Cr concentrations in ppm.

#### ***Data Analysis***

Data collected were analysed statistically using Analyse-it v.2.26 statistical software for Microsoft Excel. Summary results are presented as Mean ± Standard Deviation. The test for Analysis of Variance (ANOVA) was carried out with Tukey *post-hoc* error protection for the separation of means. The decision on statistical significance was measured at 95% confidence interval (P<0.05).

#### **Results**

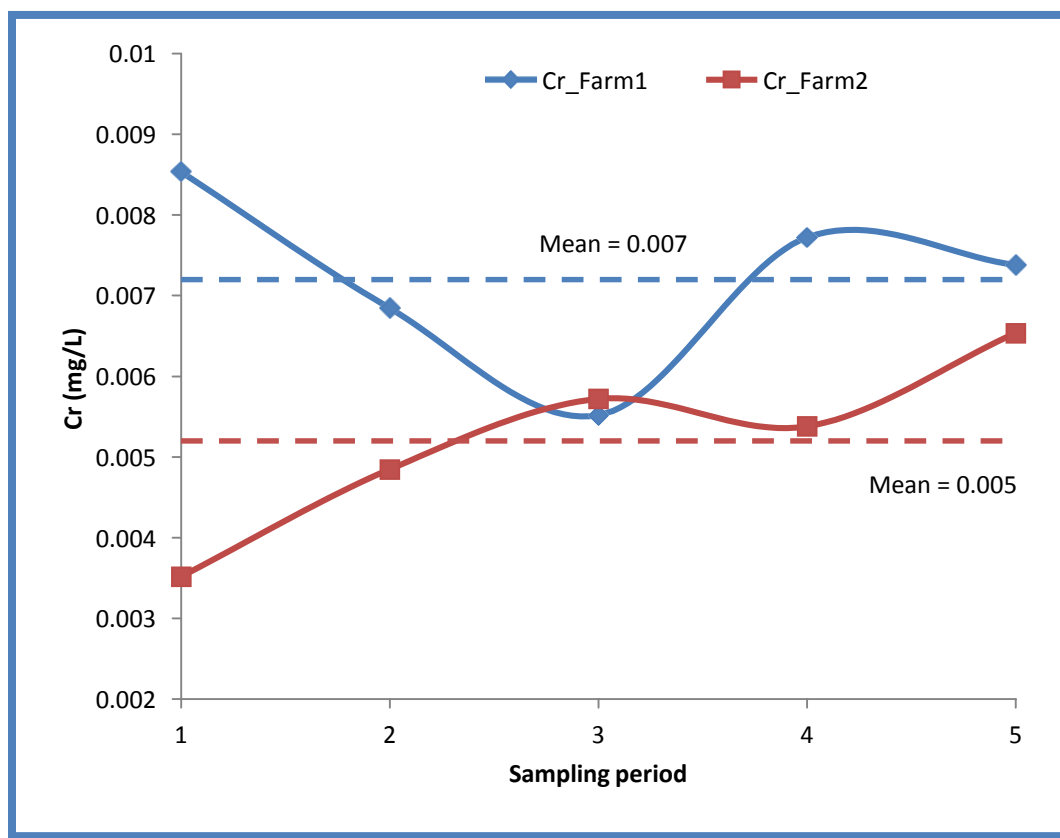
Figure 1.0 shows the result of Cr concentration in the samples of poultry feeds analysed. It revealed that Cr concentrations was similarly higher ( $0.551 \pm 0.01$  mg/g) in the livestock brand of poultry feeds, than in the hybrid ( $0.417 \pm 0.002$  mg/g). This indicated a statistically significant difference by about 32% (Appendix 1).



**Figure 1.0:** Trend plot of *Chromium* concentration (mg/g) in *Poultry Feeds*

Figure 1.1 illustrates the trend result of Cr concentration in the water samples analysed in this study. It shows that Cr concentrations was higher ( $0.007 \pm 0.001$  mg/L) in the Farm

1 than in Farm 2 ( $0.005 \pm 0.0011$  mg/g). The variation was higher by about 39% and was significant.



**Figure 1.1:** Trend plot of *Chromium* concentration (mg/L) in *Water*

Summary result of Cr concentration in the poultry drugs samples analysed is shown on Table 1.0, which revealed that all five samples analysed indicated the presence of Cr. It shows that Cr was least in Interseryl + WS (0.0382 ± 0.0004 mg/L) and highest in Introvit A + WS (0.305± 0.0030 mg/L).

The general trend of Cr in poultry drugs samples analysed ranged between 0.0377 and 0.3052 mg/L with a coefficient of variation (CV) of about 115%, suggesting a marked significant variation in Cr contents of samples.

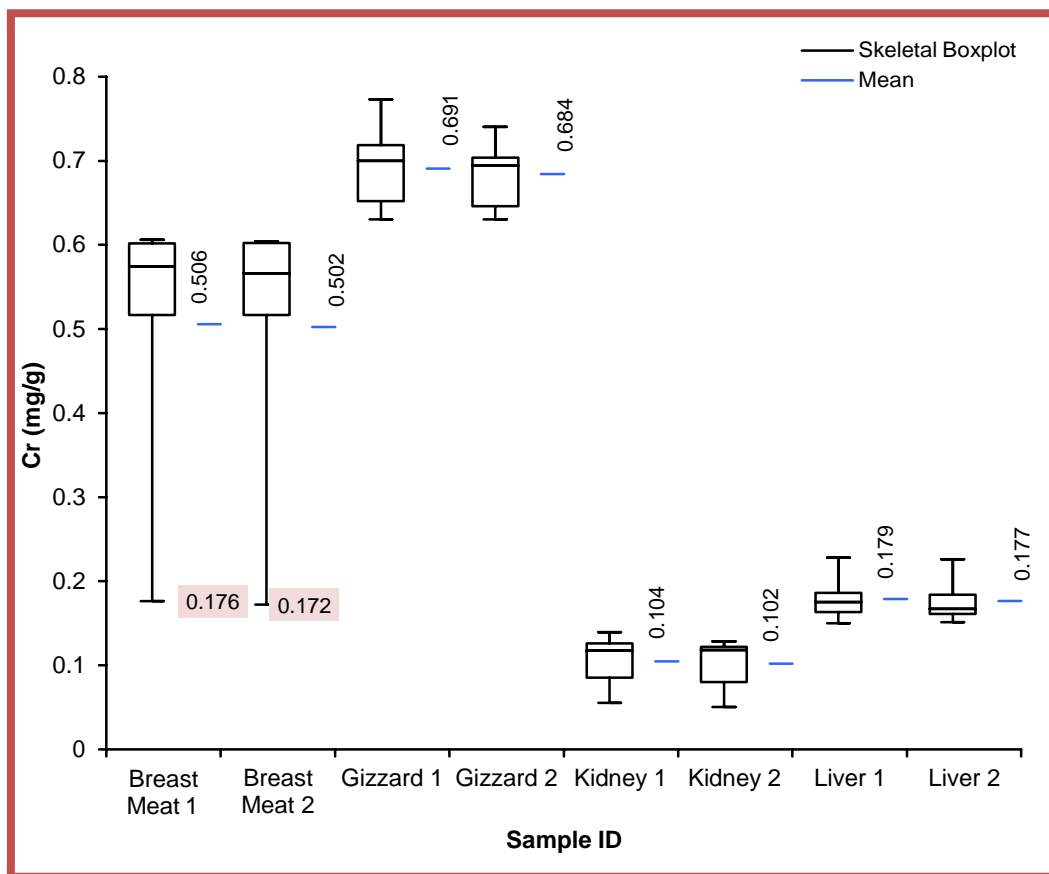
**Table 1.0:** Summary results of *Chromium* concentration (mg/L) in *Poultry Drugs*

Statistics	Interseryl +WS	Admacin e	Tylo-DOX Extra	Neoceryl plus	Introvit +WS	A
Minimum	0.0377	0.0695	0.1346	0.0575	0.3025	
Maximum	0.0385	0.0718	0.1352	0.0597	0.3085	
Mean	0.0382	0.0709	0.1348	0.0587	0.3052	
SD	0.0004	0.0012	0.0003	0.0011	0.0030	

SD = Standard Deviation

Figure 1.2 shows Cr concentration distribution in organs of layer poultry analysed in this study. It shows that gizzard of Hacco (0.691±0.042 mg/g) and Isa Brown (0.684±0.036 mg/g) form the respective Farm1 and Farm2 accumulated the highest in Cr concentrations, while liver organ were least Liver1 (0.104±0.029 mg/g) and Liver2 (0.102±0.029 mg/g) from Farm1 and Farm2 respectively.

Concentrations variations of Cr between similar organs from the two farms show no statistical significance, but variation between the different organs does, with exception of kidney and liver (Appendix 2). The observed outlier in breast meat 1 & 2 (0.176 & 0.172 mg/g) minimum concentration was excluded due to the high uncertainty. The general order of Cr concentration in layer poultry organ studied is: gizzard > breast meat > liver > kidney.



**Figure 1.2:** Box-Whisker plot of *Chromium* concentration (mg/g) in layer *Poultry Organ*

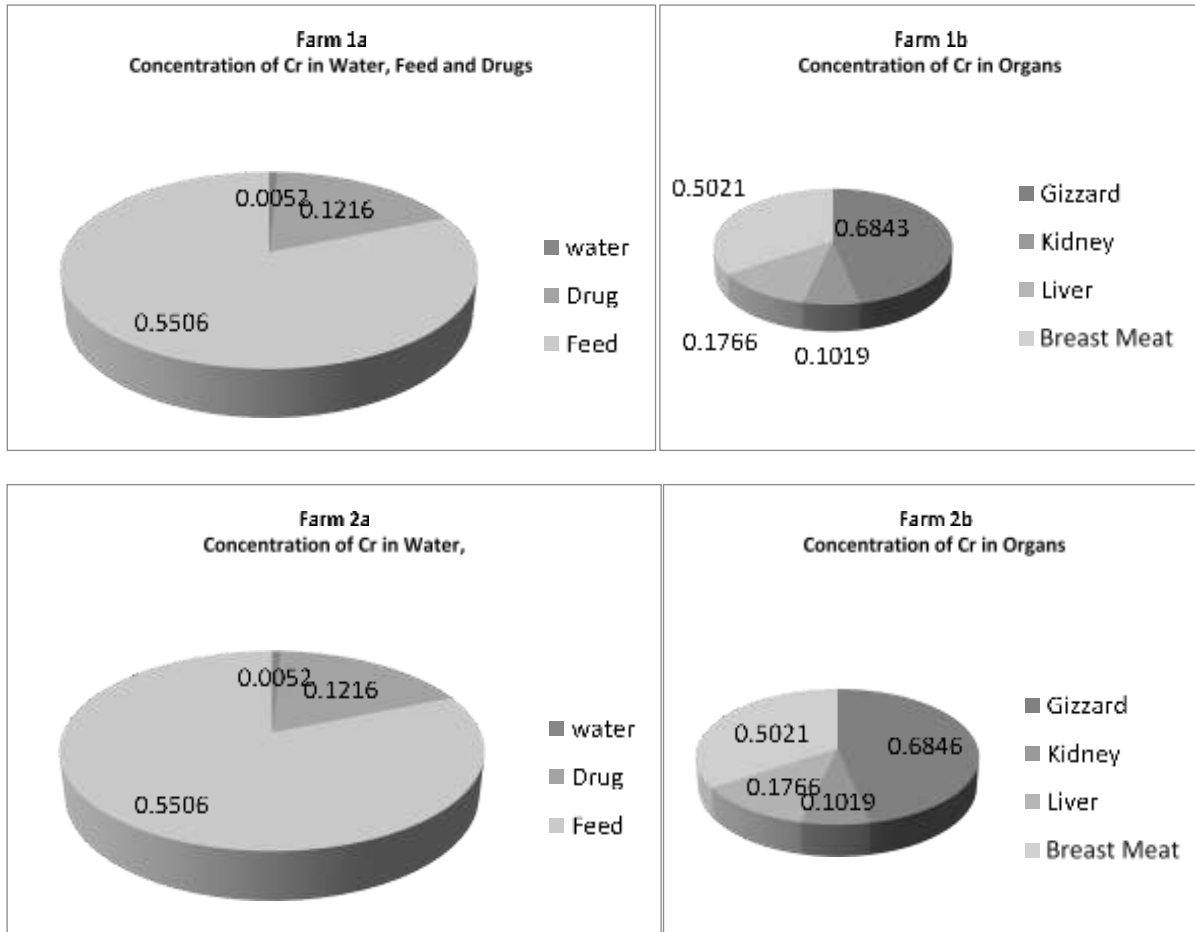
**Chromium (Cr)**

Figure 1.3 present Cr profile in source materials and indicated that its contribution to accumulation is largely dependent on the feed with and an average of 0.4166 mg/g

constituting 77%, in Farm 1 (a). This is followed by drugs (22%) and water (1%). Thus, drug and water intake in this farm poses no accumulation risk. Therefore, the distribution of Cr in organs (Farm 1 b) is

mainly sourced from the feed which was highest in gizzard by 47%. This trend is similar in Farm 2. But with a higher (81%)

contribution from feed. Therefore, where drugs not administered, the poultry feed will remain the principal culprit.



**Figure 1.3:** Concentration profile of Chromium in Feed, Water and Drugs, and layer Poultry Organs from the two farms

## Discussion

In general, Cr concentration in groundwater is low (<1 µg/l) (WHO, 2003a). The result of this study showed a range beyond this classification and as such, on the average, exceeded the guideline limits for human and animal consumption (WHO, 1993). Most especially in Farm1 the result corresponds to the findings of pervious study around the same location (Kolo *et al.*, 2009).

Cr (VI) is the toxic form of concern; however, a daily requirement for adults is estimated to be 0.5–2 µg of absorbable chromium (III) has been recommended for humans and some other animals (NRC, 1980). The concentration of Cr in both feeds was far less than that reported by Islam (2007). However, the livestock brand of feed showed higher levels of Cr as well, which have been attributed to the raw materials used in feed production (EHU, 2002). Feed and food stuff contain Cr at concentrations ranging from <10 to 1300 µg/kg (Nriagu and Nieboer 1988; MOA, 1985). Because of the carcinogenicity of chromium (VI) through the inhalation route and its genotoxicity, the current guideline value of 0.05 mg/l has been questioned, but the available toxicological data do not support the derivation of a new value. As a practical measure, 0.05mg/l, which is considered to be unlikely to give rise to significant risks to health, has been retained as a provisional guideline value until additional information becomes available and Cr can be re-evaluated (WHO, 2003a).

All drug samples administered to the chicken contained Cr. This may be connected to the essential requirement of Cr (III) as mentioned earlier. However, Introvit A+WS which showed the highest concentration far beyond the regulation limit in food and water was also reported to be high. The order of Cr

concentration in organ studied was gizzard > breast meat > liver > kidney. Iwegbue *et al.*, (2008) reported similar trend in which gizzard, in most cases, was higher in Cr. It was also established in this study that feedstuff accounts for the bulk of Cr intake by the poultry, buttressing most reports of food as being the major source of Cr. On the whole, levels of Cr in this study met the estimated daily requirement for this trace element provided that daily meat intake was no more than 100 g.

In the study, probable source of Cr burden in the organs of Adult Hacco and Isa Brown chicken layers was successfully identified by examining samples of water, drugs, feeds and organ of the Chicken Layers. The results revealed that Cr profile in source materials indicated that its contribution to accumulation is largely dependent on the feed. This is followed by drugs, then negligibly water. Thus, drug and water intake in this farm poses no accumulation risk. Therefore, the feed will remain the principal source of Cr with the gizzard being the organ with highest accumulation.

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