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Levels of Total Petroleum Hydrocarbons (TPH) and Heavy Metals in Shrimp Waste Meal Supplemented Broiler Feeds and Droppings

A A Adeniyi**[a], O O Oduguwa[b], O C Asunumeh[b], Y O Ikekhua[b] and A O Fabiyi[b]

[a]*Department of Chemical Sciences, Lagos State University, Ojo, P.M.B. 1087, Apapa, Lagos, Nigeria*

[b]*Department of Animal Nutrition, University of Agriculture, P.M.B. 2240, Abeokuta, Nigeria*

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The study determined the levels of cadmium, lead and total petroleum hydrocarbons (TPH) in shrimp waste meal supplemented feeds and droppings of the broiler birds. The samples were collected randomly over a period of two months. Cadmium and lead were determined by atomic absorption spectrophotometry, while total petroleum hydrocarbons (TPH) were determined gravimetrically by following standard methods. The results show for cadmium 0.61 ± 0.48 µg / g and 0.81 ± 0.32 µg / g, respectively; 9.49 ± 2.24 µg / g and 11.49 ± 1.55 µg / g for lead; 369.00 ± 108.40 µg / g and 330.20 ± 59.03 µg / g for TPH, respectively for the starter and finisher feeds. The statistical analysis of variance reveal significant differences at 95% confidence level for lead and TPH compared with control samples. The droppings of the broilers were also collected and analysed with statistically significant difference existing for lead.

Keywords: Shrimp waste meal, Total petroleum hydrocarbons (TPH), Cadmium, Lead, Contamination.

Introduction

Industrialization and urbanization especially in developing countries have gradually led to the accumulation of heavy metals and petroleum hydrocarbons in the environment (Adeniyi 1996; Bamgbose and Osibanjo 1998; Byomi *et al* 1999; Manay *et al* 1999; Ngodigha *et al* 1999; Yamasoe *et al* 2000; Adeniyi and Afolabi 2002). Due to the high cost and sometimes non-availability of conventional feeds, poultry farmers and researchers have in recent years resorted to a large scale usage of unconventional feeds for broiler rations (Islam *et al* 1994; Fanimo *et al* 1996).

Substituted items for fish meal in conventional feeds like shrimp waste meal and maggot meal, have been reported to be of high nutritive value (*Fanimo et al* 2000; Oduguwa *et al* 2000).

Shrimp waste meal has been identified as an animal protein source. The availability of shrimp both in off-shore water and Lagos Lagoon amounts to about 300,000 ton per year and they form the larger part of the catches of artisan fishermen and commercial shrimp trawlers. The increase in shrimp farming and production of shrimp waste meal, which is basically the dried waste of the industry, consist of the heads, appendages and exoskeleton (Fanimo *et al* 1996).

Despite, the increasing wide usage of shrimp waste meal in unconventional broiler rations nothing has been reported on the levels of potentially toxic heavy metals and total petroleum hydrocarbons (TPH) in these feeds. These contaminants may accumulate in the poultry products at levels, which may threaten public health (Kan 1994; Tsuji *et al* 1999).

Poultry droppings is a useful agricultural by-product but its potential for environmental pollution requires attention (Van der Watt *et al* 1994; Ihnat and Fernandes 1996; Martinez *et al* 2000).

This study was designed to determine the levels of cadmium, lead and total petroleum hydrocarbons (TPH) in the shrimp waste meal supplemented rations with a view to ascertain the level of safety of these feeds considering the fact that accumulation of these contaminants in the resultant poultry products may not be ruled out.

Materials and Methods

*Materials.*The samples used for this study were collected from the College of Animal Sciences Farm, University of Agriculture, Abeokuta between September and November 2000. The shrimp waste supplemented and control feeds were classified into starter and finisher mash according to the physiological stage of growth of the chicks. The control diets contained fish meal as the only protein source while in the supplemented feeds, shrimp waste meal was used to replace the fish meal in the control diets. The diets were formulated to contain the required levels of protein and energy for the respective stages viz for starter feed and for finisher feed.

*Author for correspondence; E-mail: lekeadeniyi@yahoo.com

The feed samples were collected randomly from the chicks plastic feeding trough. The birds droppings were also collected at the fourth week (end of the starter phase) and the eight week (end of the finisher phase) of the experiment. The feeds and droppings were dried in an oven (55˚C-60˚C) for four days and homogenised following the method described earlier (Hanczakowski *et al* 1995; Adeniyi 1996).

Determination of cadmium and lead. Two stocks of eight feeds/dropping sub-samples along with a "blank" containing reagent and no feeds/droppings were digested for analysis using conc. HNO_3 as described earlier (Van der Watt *et al* 1994; Ihnat and Fernandes 1996). Cadmium and lead were determined using a Buck model 200 A Atomic Absorption Spectrophotometer. This was operated according to the manufacturer's recommended conditions in replicates while pure elemental standard solutions were used for calibration.

Determination of total petroleum hydrocarbons (TPH). The total petroleum hydrocarbons (TPH) levels in the samples were determined gravimetrically using 10 - 20g dried feed/droppings, 0.6g KOH with reflux for two and half hour in 50 cm^3 n-hexane. The crude extracts were cleaned up with short silica gel columns (Kieselgel 60 F_{254}, 70 - 230 mesh) using petroleum ether as described in (IOC 1982; Hewari *et al* 1995; Onianwa 1995; Adeniyi and Afolabi 2002).

Statistical analysis. Statistical significant differences in the samples were analysed using ANOVA as described by Pentecost (1999).

Results and Discussion

Cadmium, lead and total petroleum hydrocarbons (TPH) levels shown in (Table 1) reveal varying degrees of burden in the feeds and droppings samples. The mean cadmium levels (µg/g) of 0.61 ± 0.48 and 0.81 ± 0.32, respectively for starter and finisher feeds compare favourably with the levels found in the control (0.38 ± 0.29 µg/g and 1.05 ± 0.53 µg/g, respectively). These values were however, found to be non-significant at 95% confidence level (Table 1). Nevertheless, the mean levels of cadmium in the droppings of the poultry birds fed on the control and supplemented feeds were 1.72 ± 0.36 µg/g and 1.44 ± 0.24 µg/g for starter and finisher birds fed on control feeds; 0.83 ± 0.96 µg/g and 1.45 ± 0.36 µg/g for starter and finisher birds fed on the supplemented feed, respectively. A similar trend has been observed before (Van der Watt *et al* 1994; Ihnat and Fernandes 1996; Schuler *et al* 1997; Gruszeck *et al* 2000). However, human exposure to heavy metals through accumulated metals in plant and animal tissues is of growing concern (Gardiner *et al* 1995; Adeniyi 1996; Freedman 1996; Nyobo *et al* 1996; Kugonic *et al* 1999; Hensbergen *et al* 2000). It is noteworthy that only a fraction of the total cadmium ingested are assimilated into the tissues of birds as observed by (Rambeck and Weiser 1992; Kan 1994). There are also possibilities of droppings contamination with cadmium from sources other than dietary source (Freedman 1996).

Lead has the highest mean value of 11.49 ± 1.55 µg/g in the supplemented finisher feed and statistically significant 95% confidence level (Table 1). This may be taken as an indication of lead contamination (Adeniyi 1996). The relatively high values of lead in the supplemented feed samples may not be unconnected to poor handling, particularly exposure of ingredients and products to exhaust from the Mill's diesel engine power generating plant (Lawani and Abdulmukaila 1984; Wrzesien *et al* 1999). The mean lead levels in between 4.81 ± 5.82 µg/g and 12.80 ± 4.55 µg/g for the droppings (Table 1) were generally higher than the feeds samples. This trend has been observed before (Van der Watt *et al* 1994; Ihnat and Fernandes 1996), this probably suggest contributions from aerial sources (Falahi-Ardakani 1984; Nybo *et al* 1996; Adeniyi 1996; Yamasoe *et al* 2000).

The mean TPH values for the feeds (Table 1) ranged between 209.20 ± 128.93 µg/g and 369.00 ± 108.40 µg/g. The control sample values were generally lower than the supplemented feeds samples. The starter and finisher feed samples values of 256.00 ± 152.60 µg/g and 209.20 ± 128.93 µg/g for control and 369.00 ± 108.40 µg/g and 330.20 ± 59.03 µg/g, respectively for supplemented feeds (Table 1) were found to be statistically significant at 95% confidence level. The relatively high values of TPH in the feed samples (Table 1) may be the result of contamination from exhaust fumes in the feed mill, poor handling and or through long-range air pollution of the ingredients (Schroll *et al* 1994; Lorber 1995; Larsen 1995; Douben *et al* 1997; Wiedinmyer *et al* 2000). Similarly, the mean TPH values for the droppings (Table 1) which ranged between 373.00 ± 209.78 µg/g and 605.00 ± 185.35 µg/g are generally higher than the corresponding feeds values (Table 1). Among others, this observation may not be unconnected with the burning of heavy oils (engine oil, black oil and diesel) in the vicinity of the poultry farm to keep soldier ants (*Oecaphylla longinoda*) at bay. The TPH values in the droppings, were however, found not to be significant (Table 1) at 95% confidence level.

The good and high nutritive values of these supplements as well as their affordability not withstanding (Fanimo *et al* 1996; Oduguwa *et al* 2000). There is the urgent need to pay more attention to the level of hygiene as regards the source of ingredients and handling procedures adopted in compounding the rations. This is imperative in the coming years in other to realise the full potential of these emerging new and novel feed ingredients. They no doubt have the potential to reduce the

Table 1
Concentrations (µg/g) ± SD of heavy metals and total petroleum hydrocarbons (TPH) in shrimp waste supplemented feeds and poultry droppings

S.No.		Control		Supplemented		
		Starter	Finisher	Starter	Finisher	$F_{0.05}$
1.	Cd	0.38 ± 0.29	1.05 ± 0.53	0.61 ± 0.48	0.81 ± 0.32	2.63
		(1.72 ± 0.36)	(1.44 ± 0.24)	(0.83 ± 0.96)	(1.45 ± 0.36)	1.81
2.	Pb	6.69 ± 4.03	10.41 ± 1.50	9.49 ± 2.24	11.49 ± 1.55	3.40*
		(12.16 ± 1.95)	(12.80 ± 4.55)	(4.81 ± 5.82)	(12.14 ± 1.03)	3.87*
3.	TPH	256.00 ± 152.60	209.20 ± 128.93	369.00 ± 108.40	330.20 ± 59.03	38.34*
		(377.25 ± 103.64)	(500.50 ± 198.46)	(373.00 ± 209.78)	(605.00 ± 185.35)	1.53

Notes: * significantly differences between metals and TPH in the control and supplemented feeds/droppings at $p < 0.05$. Values in parentheses are for the droppings.

cost of livestock feed production. This is coupled with its attendant multiplier effect in our quest to provide high quality animal protein to the greatest number of our citizen without compromising their future health (Beck *et al* 1994; Minissi *et al* 1998; Tchernitchin 1998; Manay *et al* 1999).

The values of heavy metals and TPH (Table 1) in the control commercial feeds, though relatively low, are equally of concern because these contaminants are known to bioaccumulate as they journey through the biological system. (Albers 1995; Mlcachlan 1996; Nybo *et al* 1996; He Yang and Cha 2000). This may have serious health implications as poultry products are important links in the complex food chain.

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