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Assessment of Plasma Biochemistry Profile of *Corvus* and Environmental Factor that Bridges the Gap between *Corvus albus* and Man in Nsukka

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ABSTRACT

The African pied crow, *Corvus albus* is a widely distributed and common African bird whose close association with man could be of public health risk. Data on plasma biochemistry profile which is indicative of the health condition of the birds in the wild is scanty while knowledge of the environmental factor that bridges the gap between the crow and man is lacking. This study evaluated the plasma biochemistry profile of *C. albus* and the environmental factor that bridges the gap between man and crow through which disease pathogens could be transmitted. The plasma biochemistry parameters of *C. albus* determined in this study are higher in females than in the males but the mean plasma biochemistry parameters are not significantly different between the sexes ($p > 0.05$). A total of 388 crows comprising 276 (71.13%) and 112 (28.87%) from food and water sources respectively were recorded in the study. The population of pied crows in food sources were significantly higher than the population in water sources ($p < 0.05$). Of the 400 individuals surveyed, 190 (47.5%) and 160 (40%) linked crows to food and water respectively while 50 (12.5%) linked crows to the two environmental factors. The relationship between food and water showed a significant relationship ($p < 0.05$) with water being scarcer in the environment. Water is the environmental factor that bridges the gap between crows and man. The biochemical parameters reveal that the crows are apparently unhealthy and could transmit pathogens to man via sharing of household water. This result is important for management of crow-man contact to safeguard the public health of rural and urban dwellers in the study area.

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IEO and JIO designed the work. IEA and ASH conducted the field work and analysed the data. IEO, JIO and ASH wrote the paper.

Key words
Crow, Food, Water, Refuse, Nsukka

INTRODUCTION

The African pied crow *Corvus albus* is a widely distributed African bird species of the *Corvus* group that occur throughout the sub-Saharan Africa (Madge and de Juano, 2017). They have been reported in Brazil (Adelino *et al*., 2017) and India (Saikia and Goswami, 2017) although they have not established a breeding population outside the native range of Africa (Adelino *et al*., 2017).

Corvus albus has been considered problematic due to its generalist mode of feeding (Adelino *et al*., 2017). They feed on a wide variety of organisms including tortoises (Fincham and Lambrechts, 2014) and carrion (Adelino *et al*., 2017), small mammals, passerines, reptiles and amphibians (Adelino *et al*., 2017), maize, groundnut, domestic chicks, eggs, scraps of human foods and fruits (Priest, 1936; Gwahaba, 1975; Igwebuike and Eze, 2010a, b). This generalist feeding habits has brought crows in very close association with man (Gwahaba, 1975; Londei, 2010; Adelino *et al*., 2017). Crows always occur in large numbers and the house crow *Corvus splendens*, a similar species was the dominant bird in Lahore Safari Zoo in Pakistan.

The African pied crow has been found to harbour ecto and endoparasites such as mites, lice, ticks, pupiparan flies, tapeworm and filaria nematodes (Gwahaba, 1975; Ihedioha *et al*., 2011). Their habits of being in refuse dumps and carrion in search of food, and their close association with humans could be disastrous. In effect, these can cause a health hazard to urban and rural populations as they could act as vectors of human and animal disease causing agents (Gwahaba, 1975; Ihedioha *et al*., 2011). Crows have been associated with the transmission of numerous pathogens such as *Salmonella* and *Campylobacter*, and viruses such as the human influenza virus and orthoreovirus (Romvary *et al*., 1976; Huhtamo *et al*., 2007; Ryall and Meier, 2008).

The pathogens that crows harbour has made them serve as indicator species for surveillance of avian influenza and West Nile fever (Steele *et al*., 2000; Eidson *et al*., 2001; Panella *et al*., 2001; Perkins and Swayne,

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2001; Brault *et al*., 2004; Tanimura *et al*., 2006; Huhtamo *et al*., 2007). The pathogens have been shown to induce significant organ damage and in some cases death of the crows, and this has placed crows as a species to be monitored for surveillance of these diseases (Steele *et al*., 2000; Eidson *et al*., 2001; Panella *et al*., 2001; Perkins and Swayne, 2001; Brault *et al*., 2004; Tanimura *et al*., 2006; Huhtamo *et al*., 2007; Ihedioha *et al*., 2011).

The habits of feeding in refuge dumps exposes crow to pathogens. Food resource availability and quality have been shown to alter the blood parameters of organisms (Vleck and Vleck, 2002). Assessment of serum biochemistry profile provide a medium for predicting pathological changes in body organs such as kidney, liver, heart, pancreas, and muscles (Tyson and Sawhney, 1985; Campbell and Coles, 1986; Harr, 2002; Campbell, 2004). The study of biochemical parameters in animal is vital for evaluating their physiological state in the wild (Jenni and Schwilch, 2001; Sánchez-Guzmán *et al*., 2004; Elarabany, 2018). Plasma biochemical profiles are useful parameters for the study of physiological state of free-living birds (Jenni and Jenni-Eiermann, 1998; Ibanez *et al*., 2015). Deviation in the normal serum biochemistry could predict pathological effects and organ damage in crows, a state of unhealthy conditions (Ihedioha *et al*., 2011).

Corvus albus are widely distributed in the study area and their habit of feeding on free range chicks has constituted a major problem to poultry industry in the area. They also frequently drink water from the earthen pots and other water storage containers such as plastic bowls, buckets, drums and tanks used by the rural and urban dwellers to store water thus, contaminating the water.

Assessment of plasma biochemistry profile of crows will determine if the crows are healthy or not and will form the basis for advising the general public on how to deal with crows including keeping them as pets. Study on plasma biochemistry profile of African pied crow is scanty. In addition, crows come in close contact with man in search of food and water in the environment. Knowledge of the environmental factors that bridges the gap between crow and man has not been addressed and such data will enable management of the bird to reduce crow-human contact. The objectives of this study therefore were to assess some plasma biochemistry profile of the African pied crows with a view to ascertaining the health status of the bird and determine the environmental factor that bridges the gap between man and crow in the study area.

MATERIALS AND METHODS

Study area

The study was conducted in Nsukka Local Government Area (LGA), Enugu State of Nigeria. Nsukka LGA is located between latitude 5°50′ and 7°00′ North and longitude 6°52′ and 7°54′ East (Figs. 1 and 2). Nsukka LGA has a tropical climate, with annual rainfall ranging from 986 to 2098mm (Inyang, 1978). The natural day length for Nsukka is 12 - 13 h and the average annual maximum and minimum temperatures are 29.7 °C and 21.0 °C, respectively. The relative humidity ranges from 34 to 78% (Monanu, 1975). Nsukka LGA is a peri-urban area and lies within the derived savannah vegetation zone, characterized by incomplete canopy cover (Ofomata, 1995). Nsukka shares boundaries with Igbo-Etiti LGA on the South, Uzo-Uwani LGA on the West, Udenu LGA on the East and Igboeze-South LGA on the North, all in Enugu State. Nsukka is a business area and is also home to the University of Nigeria hence, students and workers reside in this area. In addition, subsistence agriculture is the main occupation of the rural indigenes of Nsukka LGA. Nsukka has an approximate population of 309,633 people as at 2006 national census, 17.52 square miles total land area and a home to members of the Igbo ethnic group (FRNOG, 2007).

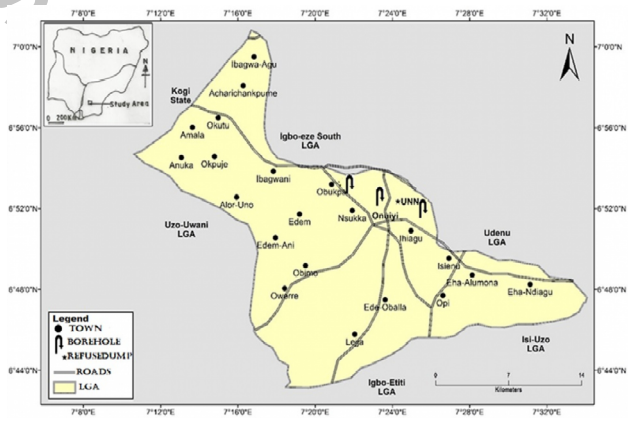

Fig. 1. Map of the study area.

Collection of Corvus albus

The *C. albus* used in this study were trapped by the staff of Zoological Garden, Department of Zoology and Environmental Biology, University of Nigeria, Nsukka. The birds were trapped using food as a bait near refuse bins within the premises of University of Nigeria, Nsukka. In all, 10 *C. albus* were caught and used for the study. The crows were used immediately after trapping so that any observation on the plasma biochemistry could be taken as its state of health in the environment.

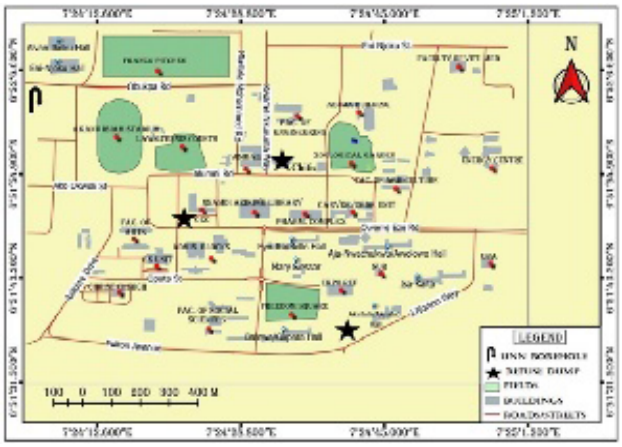

Fig. 2. Map of University of Nigeria showing the refuse bin sites and borehole.

Determination of biochemical parameters of plasma

The feathers of the neck region were quietly removed, and 4 ml of blood was collected by venipuncture of the jugular vein. The blood collected was emptied into EDTA bottle and centrifuged at 3000 rpm for 15 mins to obtain the plasma. The plasma was then used in the determination of all the biochemical parameters. Prothrombin time (PT) and blood urea nitrogen (BUN) were determined following the methods of Ochei and Kolhalter (2000). Total protein was determined using the Lowry's method (Lowry *et al*., 1951) for protein determination. The erythrocyte cell sedimentation rate (ECSR) was determined using the Westergren method (Ochei and Kolhalter, 2000). Acid and alkaline phosphatases (ACP and ALP) were determined using the two-point method: Waus Walter and Christian Schutt (Ochei and Kolhalter, 2000) while alanine aminotransaminase (ALT) and aspartate aminotransferase (AST) were determined using the colorimetric method of Reitman and Frankel (1957).

Observation and counting of C. albus *population in food and water sources in the study area*

Food and water are the two main environmental factors that brings pied crows close to humans. In order to determine which of the two environmental factors (food and water) that drives crows closer to man, a field observation and population count was conducted for pied crows in refuse bins and water boreholes in the study area. Three refuse bins within the University of Nigeria which included refuse bins near Akintola/Akpabio Hall, CEC restaurant and Chitis restaurant were used to study *C. albus* population in food sources. Similarly, three water boreholes which included University of Nigeria, Nsukka Borehole, Nsukka Township Borehole, and New Carolina Hotel Borehole were used to assess *C. albus* population in water sources. These boreholes were chosen because they dispense water to water tankers giving room for large volumes of water to overflow and collect in the soil near the borehole. Each of the refuse bins and borehole was sampled twice a month for 10 months from November 2017 to March 2018 and repeated from November 2018 to March 2019. Each site was observed for 2 h from approximately 90 meters and the number of pied crows that visit the refuse bins for food or the boreholes to drink water were counted and recorded. The counting did not distinguish a crow that flew away from the site and came back again hence, each landing of a crow was counted as new arrival.

To ascertain which of the two identified environmental factors that bridges the gap between pied crows and humans, questionnaires were used to gather information about crow-human contact across Nsukka cultural zone. A "Yes" and "No" options were provided for the questions Have you seen crow drinking water in your house? and have you seen crow picking food or searching for food in your house? The questionnaires were distributed to 400 individuals in the study area, and the information provided was used to access crow-human contact and the factor(s) that bridges the gap between man and crows.

Statistical analysis

The data collected on the biochemical parameters were subjected to one-way analysis of variance (ANOVA) using SPSS version 21.0 (SPSS INC. Chicago, IL. USA). The plasma biochemistry indices were presented as mean ± standard error of mean (mean±SE). Student *t*-test was used to compare differences in biochemical parameters between the sexes of the crows. The data collected on crow visit to refuse bin sites and water boreholes were subjected to one-way ANOVA with post-hoc Turkey HSD Test Calculator with Scheffe, Bonferroni and Holm multiple comparison. The questionnaire was transformed into binomial data with Yes= 1 and No= 0. The data was analyzed using Chi-Square Calculator 2x2 (with Yates correction) using online version of Chi-Square calculator (Preacher, 2001). Significance level for all the analysis were set at $p < 0.05$.

RESULTS

Biochemical profile of Corvus albus

The total protein ranged from 4.65g/dl in females to 5.77g/dl in male, ALT ranged from 57.86 IU/L in male to 94.70 IU/L in female, ALP ranged from 22.08 IU/L in males to 73.67 IU/L in female, ACP ranged from 1.57 IU/L to 11.64 IU/L in male, AST ranged from 74.60 IU/L in males to 131.66 IU/L in females, BUN ranged from 7.57

mg/dl in male to 7.95 mg/dl in female, prothrombin time ranged from 11.24 sec in male to 11.84 secs in female while ECSR ranged from 4.40 mm in male to 4.80 mm in female. The mean plasma biochemistry profile for the 8 parameters examined are not significantly different between the males and females ($p > 0.05$). Except for total protein which has the lowest value in females and the highest in males and the ACP which has both the lowest and highest values in males, the remaining six parameters have the lowest values in males and the highest values in females. The mean biochemical parameters are higher in females than in the males except for AST which is higher in males and total protein which is equal in both sexes (Table I).

Population of crows in the food and water sources and crow-human contact

A total of 388 crows comprising 276 (71.13%) from refuse bins and 112 (28.87%) from water boreholes were counted in the six study sites. The population of pied crows in refuse bins were significantly higher than the population in water boreholes ($p < 0.05$). On the contrary, there were no significant difference in the population of crows in the three boreholes or the three refuse bin sites (Table II). Crows are less frequent in water boreholes but gather in large numbers in the boreholes. However, crows gather in fewer numbers but more frequent in the refuse bins.

Of the 400 individuals that participated in the survey, 190 (47.5%) linked crows to food in the house, 160 (40%) saw crows drinking water in the house while 50 (12.5%) have seen crow carrying food and drinking water in the house. A chi-square test of independence performed showed significant relationship between the two variables, X^2 (1, N = 400) = 4.57, p = 0.03. The chi-square statistics between the two variables with Yates correlation is also significantly difference $p < 0.05$. It was determined from the study that water is scarcer than food for crows and that water is the environmental factor that bridges the gap between crows and man. The study also revealed that man share household water with crows and constitute a risk factor for disease transmission in the study area.

DISCUSSION

The mean values of ALP, ALT and AST recorded in this study lies within the range reported by Ihedioha *et al.* (2011) for unhealthy *C. albus* in Nsukka. In comparison with other birds, the values are far above that recorded by Albokhadaim *et al.* (2012) on local chicken in Al-ahsa, Saudi Arabia but far below the values recorded by Han *et al.* (2016)

Table I. Plasma Biochemical Profile of male and female African pied crows.

Biochemical parameters	Males		Females	
	Mean±SE (n=5)	Range	Mean±SE (n=5)	Range
ALT (IU/L)	60.29±0.74	57.86–62.50	81.70±3.96	69.70 - 94.70
ALP (IU/L)	38.41 ±4.72	22.08–51.33	39.27±8.69	25.88 –73.67
ACP (IU/L)	8.14 ± 1.71	1.57–11.64	10.56±0.33	9.24 – 11.10
AST (IU/L)	106.72±8.99	74.60–130.35	98.11±8.72	80.46–131.66
Total protein (g/dl)	5.20 ± 0.32	4.66–5.77	5.20 ± 0.55	4.65 –5.75
BUN (mg/dl)	7.72 ± 0.09	7.57–7.91	7.86 ± 0.09	7.76 –7.95
Prothrombin time (secs)	11.32 ± 0.043	11.24–11.38	11.64±0.20	11.44 – 11.84
ECSR (mm)	4.46 ± 0.66	4.40–4.60	4.70 ±0.10	4.60 – 4.80

ALT, alanine transaminases; ALP, alanine phosphatases; ACP, acid phosphatase; AST, aspartate transaminase; BUN, blood urea nitrogen; ECSR, erythrocyte cell sedimentation rate.

Table II. Population counts of *Corvus albus* in the study locations.

	UNN bore-hole	Nsukka town-ship borehole	New carolina borehole	CEC restaurant	Chitis restaurant	Akintola/ akpabio hall	Pooled Total
Number of days sampled	20	20	20	20	20	20	120
Number of pied crows counted	38	41	33	97.00	89	90	388
Mean±SE	1.90±0.32[a]	2.05±0.35[a]	1.65±0.29[a]	4.85±0.57[b]	4.45±0.69[b]	4.50±0.63[b]	

Mean values with different numbers as superscripts in a row differ significantly ($p < 0.05$).

on Oriental white stork in Korea. The mean values of ACP 8.14 ± 1.71 for males and 10.56±0.33 for females recorded in this study is above the 3±0.7 for males and 3.83±0.9 for female recorded by Albokhadaim *et al*. (2012) on local chicken in Saudi Arabia. The value of AST and ALP in this study are respectively higher and lower than that recorded for *Anas* spp. in Egypt (Elarabany, 2018).

The higher mean level ALT and ALP recorded for the female African pied crow relative to the males in this study may be the result of differences in the reproductive demand for either sexes. Alodan and Mashaly (1999) discovered that egg laying influences the level of the liver in female birds. Aspartate aminotransferase (AST) is used to infer damage to the liver and muscle (Harr, 2002) and the higher values obtained in this study could be indicative of unhealthy conditions as a result of organ damage. The higher mean AST recorded in the males could be attributed to organ damage since increase in this enzyme as a result of reproductive demand do not affect the males. The mean prothrombin time and erythrocyte cell sedimentation rate recorded in this study lies within the reference range reported for other wild and companion avian species (Campbell and Coles, 1986).

The mean values of total protein 5.20 ± 0.32 in both sexes exceeds the values recorded for Ihedioha *et al*. (2011) for both apparently healthy and diseased African pied crows in Nsukka, Han *et al*. (2016) who recorded 3.6 ± 0.6 g/dL for species less than one-year-old and 4.5 ± 0.9 g/dL for species greater than one-year-old in *Ciconia boyciana* in Korea, and Albokhadaim *et al*. (2012) who recorded total protein of 3.8±0.9 g/dL for male and 3.3±0.5 g/dL for female local chickens in Saudi Arabia. However, the values of 5.2011 ± 0.3218 g/dL for males and 5.20± 0.55 g/dL for females recorded in this study is far below the values of 38.6 ± 1.39 g/dL (day 1), 41.5 ± 1.55 g/dL (day 42) and 25.5 ± 4.66 g/dL (day 84) recorded by Hrabláková *et al*. (2014) during egg laying in pheasant hens in Czech Republic, and 6.975 ± 0.42 and 7.1 ± 0.29 reported for *Anas clypeata* and *Anas crecca* respectively in Egypt (Elarabany, 2018).

The value of blood urea nitrogen 7.72±0.09 mg/dl for male and 7.86±0.09 mg/dl for female recorded in this study is above the values recorded by Albokhadaim *et al*. (2012) on local chicken in Saudi Arabia, and that recorded by Han *et al*. (2016) on *Ciconia boyciana* in Korea but lower that that recorded on *Anas* spp. by Elarabany (2018) in Egypt. However, the blood urea nitrogen recorded in this study lies within the range recorded by Ihedioha *et al*. (2011) on both healthy and disease African pied crows in Nsukka. Similarly, the BUN recorded in this study lies within the range of 7mg/dl in common buzzard and 14.9 mg/dl in vulture (Balasch *et al*., 1976). The values of biochemical parameters examined in this study deviated from the range of values recorded in most other birds hence, the crows examined are apparently unhealthy.

Food and water are the basic need of *C. albus* in their environment. Food is more abundance and widespread since there are refuse dumps at every corner of human habitation and markets compared to water that are obtained only from boreholes in the study area. The three refuse bin sites sampled represented only about 8% of the total refuse bin sites in the University of Nigeria, Nsukka while the borehole is the only one available in the University. Besides, the birds feed on a wide range of food in their environment hence many crows rarely gather for a food source. On the contrary, water is scarce for *C. albus* in the study area and that could explain the concentration of *C. albus* in water boreholes which is the only source of water in the study area.

The activities of man influenced the population of crows in the two environmental factors sampled. The refuse bin sites are along the roadsides for easy access to waste management authorities. This location made crows to fly off at the approach of vehicles or humans. Similarly, the water boreholes often have water tankers and individuals around which made crows to stay away during the period of human activity in the area.

Corvus albus has been frequently observed to drink water from earthen pots and other water storage containers used by humans in storing water for drinking and other household use. This could be because of the scarcity of water in their environment. This sharing of household water between man and crow constitutes a public health risk for water borne diseases. Although *C. albus* are also seen searching for food around homes, they are restricted only to refuse bins or waste food that are no longer useful for human consumption. Hence, the environmental factor that bridges the gap between *C. albus* and man is water.

In conclusion, the plasma biochemistry profile of the crows studied indicates that the crows are apparently unhealthy and might be harbouring pathogens which can be transmitted to man. Apart from the biochemical parameters which shows that the crows are apparently unhealthy, the birds could also be mechanical carriers of parasites and pathogens which could result in water borne diseases when they contaminate household drinking waters. Water bridges the gap between man and crows hence, provision of pipe borne water for households especially in rural areas which in effect will discourage or reduce the use of earthen pots, buckets and empty drums in storing household waters is recommended to deny crows access to household waters. Households should also be educated to avoid crows contaminating their household waters and not keep them as pets. Food and water are the two major environmental

requirements that bring crows in close contact with man and this understanding can be used to conserve the birds and safeguard the health of the general public in relation to crows especially in sub-Saharan Africa.

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Statement of conflict of interest

The authors have declared no conflict of interest.

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