

Evaluation of the food of red-billed quelea (*Quelea. quelea*) during off-cropping season in Gyawana ecosystem Adamawa State

Buba, Z.M ^{1,*} Ussa, J ² and Sabastian, M.M ²

¹ Department of Zoology, Adamawa State University Mubi, Adamawa State, Nigeria.

² Department of Botany, Adamawa State University Mubi, Adamawa State, Nigeria.

World Journal of Advanced Research and Reviews, 2022, 15(02), 516–524

Publication history: Received on 30 July 2022; revised on 20 August 2022; accepted on 22 August 2022

Article DOI: <https://doi.org/10.30574/wjarr.2022.15.2.0790>

Abstract

The evaluation of the food items of red-billed quelea during off-cropping season in Gyawana ecosystem was carried out, to ascertain the wild food of *Quelea quelea* foraged on during off-cropping season. Red-billed quelea (*Q. quelea*) devastation of crops continues to be a problem that militates against food security in Adamawa State and other arid regions of Nigeria. The bird appears to have alternative food sources which ensure its survival and breeding during off-cropping seasons. The crop contents of *Q. quelea* were analysed. Nine (9) different food items were identified including seeds of different grasses, insect remains and Grits from the crops of one hundred and fifty (150) *Q. quelea* sampled for this study. *Echinochloa colonum* has the highest frequency and magnitude of occurrence in the food items foraged on by the *Q. quelea* with a mean value of 40.20 ± 0.72 , followed by *Digitaria ciliaris* (35.33 ± 1.03), *Digitaria iburua* (29.96 ± 1.12), *Setaria pallidofusca* (29.33 ± 0.41), *Roetboellia exaltata* (21.67 ± 0.25), *Brachiaria mutica* (1.71 ± 0.16) and the least seed consumed is *Cenchrus biflorus* with a mean of 1.15 ± 0.02 . Grits was consumed in small quantity (0.15 ± 0.36) by both sexes, while insects remained was observed only in female's crop of the Quelea birds. Analysis of variance was used to compare the mean number of various seeds consumed by the *Q. quelea* during the period of the study. The result shows no significant difference in the food items consumed by Red-billed Quelea during off-cropping season at $P > 0.05$. Based on the findings of this research work, the researchers therefore, recommend that further study should be carryout on the food items of *Q. quelea* during cropping season and also biological control of this Quelea birds (*Q. quelea*).

Keywords: Food; Red-Billed Quelea; Gyawana; Ecosystem; Off-cropping; Season

1. Introduction

Quelea bird (*Quelea quelea*) is also known as Red-billed Quelea, they are the world's most abundant wild bird with an estimated adult population of 1.5 billion (Oschadleus, 2000; Safford; 2013). *Quelea quelea* is native to sub-Saharan Africa (Craig, 2010). They are small, highly gregarious birds with average length of 12.5 cm and weigh between 15-20 grammes (BirdLife international, 2013). Apart from their deep red bills, non-breeding males and females have a drab non-descript plumage at which stage they resemble sparrows (Borello and Cheke, 2001; Burrow and Demey 2001; Oschadleus, 2015). During the breeding season which occurs in the rainy season, the males have distinctly coloured heads and bills (Cheke *et al.*, 2007; Robert *et al.*, 2007). Red-billed Quelea usually moves in flocks of several hundreds and has a capacity for long distance migration (Elgood, 1982; Liroyd, 1999; BirdLife international, 2013).

Red-billed Quelea is prominent avifauna of most countries south of the Sahara (BirdLife International, 2013). There are three Species of *Quelea quelea* with little or no genetic variation that occurs over areas in Africa (GTZ, 1987; Craig, 2010). *Quelea quelea* occurs mainly in West Africa, *Q. aethiopica* in Sudan, Ethiopia and northern Somalia, while *Q. lathamii* is found in Somalia, Kenya, Tanzania, South Africa and Angola, while *Quelea quelea quelea* is found in Nigeria (Jones *et al.*,

* Corresponding author: Buba, Z.M

Department of Zoology, Adamawa State University Mubi, Adamawa State, Nigeria.

2001; Dallimer *et al.*, 2003). In Nigeria the areas fitting and most suited therefore for *Quelea* bird are Borno, Yobe, Adamawa, Jigawa, Kano, Kaduna, Sokoto, Zamfara and Bauchi States (Walter, 1971; Safford, 2013). The Lake Chad region is home to a hybrid population of *Quelea quelea quelea* and *Quelea quelea aethiopica*. The hybrid population of *Quelea quelea aethiopica* and *Quelea quelea lathami* occurs in East Africa (GTZ, 1987; Cheke *et al.*, 2011).

The feeding regime of the Red-billed *Quelea* according to (Ward 1965), (BirdLife international, 2004), (Bernitz, 2010) and (Carina *et al.*, 2013) consists of wild annual grasses and drinks of water twice a day. In Ethiopia Erickson, (1979) however, found *Quelea quelea* dispersing from grassland region into areas of cereals cultivation where they caused appreciable damage to ripening sorghum at a time when wild grass seeds should be abundantly available. The disparity in observation of Ward, (1965) and Erickson (1979) could have been due to different species of wild grass in each case or even differences in the sub-species of bird involved.

Quelea quelea devastation of crops continues to be a problem that militates against food security in Adamawa State and other arid regions of Nigeria (Ezealor and Giles 1997; Anonymous, 2001; Cheke *et al.*, 2013). The bird appears to have alternative food sources which ensure its survival and breeding during off-cropping seasons. Not very much has been done to understand the alternative foods and other wild food species that are consumed by the birds in Gyawana ecosystem and environs, Lamurde Local Government Area, Adamawa State, Nigeria, hence the need for this study. In the year 2017, Nigeria spends two hundred and twenty six million naira to forestall *Quelea* birds' epidemic (Audu, 2017). There was also a report from Kazaure (2019), that Federal Government carried out an intensified aerial spray of pesticides (Queletox) to control invasion of *quelea* birds in north eastern part of Nigeria. There was a case in Sokoto State of Nigeria, where farmers reported that they lost battle with *Quelea* birds (Muhammad, 2019). Strategies adopted so far have been chemical. Perhaps biological mitigation measures that divert the birds' attention from cultivated cereals may present a better alternative. So far nothing has been reported in the area of "lure food items and their effect in mitigating *Quelea quelea* damages on crop feeds." This research will be a step in that direction. This research work aimed at identifying food items of the Red-billed *quelea* (*Quelea quelea*) in Gyawana Ecosystem, Lamurde Local Government Area of Adamawa State, Nigeria.

2. Material and methods

2.1. Study Area

The study was conducted in Gyawana ecosystem, Lamurde Local Government Area, Adamawa State of Nigeria. Gyawana is located at latitude 9°.35' N and longitude 11°.55' E and is 135 meters above Sea level. Lamurde Local Government Area lies between longitude 9°.36' 03.92"N, and latitude 11°.47' 36.25"E at an elevation of 137 meters above sea level, figure 1. Adamawa State is located in the North Eastern part of Nigeria, and lies between latitudes 7° and 11° N and between longitudes 11° and 14° E. It is on an altitude of 185 meters above Sea level and covers a land area of about 39,741km² (Adebayo *et al.*, 2012).

2.2. Sample Collection

2.2.1. Trapping of the birds

A total of one hundred and fifty (150) male and female birds were captured in the wild; using black nylon mist nets with dimensions of 7 x 2.5m and mesh size of 16 mm. Subtotals of fifty *quelea* birds were captured per month. The birds were captured at their night roosts and water drinking points. The mist nets were set between 9:00a.m and 11:00 a.m to catch the birds that went to drink after morning feeding and 5:00pm and 6:00 pm to catch those that went to drink before going to their night roosts as in (Kirkpatrick *et al.*, 1969; Jonathan and Frederich, 1994; Buij, 2012). Birds were trapped fortnightly for a period of three months March to May, 2022; two days were spent collecting samples at each site. Eight (8) birds each were collected at Gokumbo and Nguro Bemun Rivers sampling sites and nine (9) birds were collected at Italiah Canal River, making a total of twenty five (25) *quelea* birds in the first phase of trapping. The same numbers of *quelea* birds were collected in the second phase of trapping, making a total of fifty *quelea* birds in each month. Following the method of (Kirkpatrick *et al.*, 1969; Buba *et al.*, 2013), twenty five birds of either sex with full or partially full crops were collected and used for the crop contents analysis. Netted birds that are not needed for this research were removed from the mist net and release back to the wild.

2.2.2. Sacrificing Birds to Obtain Crop Contents

Netted *Quelea* birds were carefully removed from the mist net and immediately killed by suffocation with chloroform in air tight transparent plastic containers for about ten (10) minutes as in Yusufu *et al.*, (2004ab). The dead birds were dissected as in (Kirkpatrick *et al.*, 1969; Yusufu *et al.*, 2004ab). The crops were cut open with a pair of scissors and the

contents put into a fine sieve, washed with cold water and air dried on Petri-dishes for three hours at 37°C – 40°C. Each dried crop content of a quelea bird was put in small brown envelop and labeled according to the sex of the quelea bird, date the bird was caught and site where the bird was caught. The samples were then transported to the Department of Zoology laboratory, Adamawa State University Mubi, for further analysis.

2.2.3. Analysis Of The Crop Contents.

Following the method of Yusufu *et al.*, (2004a), crops content were sorted out based on their physical idiosyncratic using visual observation with the aid of magnifying lens. The seeds, insects remained and grits were counted and recorded. Some of the physically unidentifiable foods items especially seeds were sown in sterilized soil in a germinating tray placed in a glass house and watered daily to enable them germinate. Where germination occurred, the plants were nursed to flowering for easy and further identification. The germinated plants and the food items found in the birds' crops were identified with the help of preserved specimens in the herbarium, Department of Biological Sciences, Ahmadu Bello University, Zaria and Department of Botany, Adamawa State University, Mubi.

2.3. Vegetation and Soil Analysis

A random survey of seed plants was made particularly around the vicinity where the birds foraged. Seeds of the plants within the vicinity were then compared with those present in the crops of the birds; this was done particularly for grass seeds. The top soil in the foraging habitat was collected from fifteen different sites using a quadrant of 30 x 30 cm, thrown randomly, five times at each site of the study area. The soils were irrigated in a germinating tray, to determine plants represented in the soil seed reserves. The seeds were also compared with the seeds in the crops of dissected birds as in (Buba *et al.*, 2013).

2.4. Statistical Analysis

One way analysis of variance (ANOVA) was used to analyze the data obtained, the Student t-test was used to test for difference between the male and female food items consumed by the *Q. quelea* and Duncan's Multiple Range Test (DMRT) was used for means separation. Statistical software package (SPSS for Windows) was used. The results were presented as mean±standard error and P > 0.05 was regarded as not statistically different.

3. Results

Table 1a The mean food items observed from the crop of female Red-billed Quelea from the Months of March - May

Months	Bm Mean S.E	Cb Mean S.E	Dc Mean S.E	Di Mean S.E	Ec Mean S.E
March	26.36 ± 3.01	0.38± 0.73	31.05± 1.04	26.02± 1.04	32.01± 4.02
April	21.19±1.72	11.03±1.04	35.41±0.07	36.94±3.15	38.27±2.09
May	17.264±0.91	13.02 ±1.07	40.16±0.70	29.07±0.61	41.03± 0.91

Table 1b The mean food items observed from the crop of female Red-billed Quelea from the Months of March - April

Months	Re Mean S.E	Sp Mean S.E	Grit Mean S.E	In Mean S.E
March	28.04± 2.05	30.02± 1.00	0.41 ± 0.13	0.21 ± 0.10
April	21.16 ±1.13	31.20 ±0.92	0.43 ±0.67	0.00 ±0.00
May	16.64 ±08.03	27.61 ±1.44	0.50 ±0.72	03.2 ±1.41

P >0.05; Key: Bm =*Brachiaria mutica*; Cb= *Cenchrus biflorus*; Dc= *Digitaria ciliaris*; Di = *Digitaria iburua*; Ec= *Echinochloa colonum*; Re= *Roetboellia exaltata*; Sp= *Setaria pallidofusca*; In= Insect

The food items of Red-billed Quelea (*Quelea quelea*) during off-cropping season in Gyawana Ecosystem, Lamurde Local Government Area of Adamawa State, Nigeria, reveal nine different food items (seed of different grasses, insects remained and grit), were recovered from the crops of one hundred and fifty (150) Red-billed Quelea sampled for this period of study. The food items were presented in Table 1 to 3 as shown below.

3.1. The food items observed from the crop of female *Quelea quelea* for the month of March to May, 2022

In the month of March, there were nine different food items including different grass seeds, grit and insect remains observed in the crop of female *Quelea quelea* sampled in this study. *Echinochloa colonum* was the most consumed food item with a mean of 32.01±4.02. This was followed by *Digitaria ciliaris* with a mean of 31.05±1.04 and the least consumed seed for this month was *Cenchrus biflorus* with a mean of 0.38±0.73 as presented in Table 1 above.

Eight (8) different food items were consumed in the month of April by the female *Quelea quelea* sampled for this study as presented in table 1. *Echinochloa colonum* was the most consumed food item having the highest mean of 38.27±2.09, followed by *Digitaria iburua* with the mean of 36.94±3.15, while *Cenchrus biflorus* was again the least consumed food item, with the means of 11.03±1.04. There was no insect’s remained observed in the crops of female *Quelea quelea* sampled for this month.

From the crop of female *Quelea quelea* sampled in the month of May, *Echinochloa colonum* was again the most preferred food item with the mean of 41.03±0.91, followed by *Digitaria ciliaris* with the mean of 40.16±0.70, while *Cenchrus biflorus* again was the least consumed food item, with the means of 13.02±1.07 as shown in Table 1.

Table 2a The mean food items observed from the crop of male Red-billed Quelea from the Months of March - May

Months	Bm Mean S.E	Cb Mean S.E	Dc Mean S.E	Di Mean S.E	Ec Mean S.E
March	30.36 ± 5.01	1.03± 0.09	33.01± 1.07	23.46± 1.07	34.03± 3.12
April	19.19±1.32	13.00±2.01	38.21±0.13	35.25±1.09	39.31±3.03
May	20.264±1.01	16.05 ±1.02	39.13±1.21	31.09±0.42	49.07± 0.73

P > 0.05

Table 2b The mean food items observed from the crop of male Red-billed Quelea from the Months of March - April

Months	Re Mean S.E	Sp Mean S.E	Grit Mean S.E	In Mean S.E
March	29.03± 3.03	32.07± 1.08	0.91 ± 0.11	0.00 ± 0.00
April	27.15 ±0.19	29.14 ±0.17	0.70 ±0.37	0.00 ±0.00
May	20.27 ±1.03	29.33 ±1.37	0.61 ±0.53	0.00 ±0.00

P > 0.05

3.2. The food items observed from the crop of male *Quelea quelea* for the month of March to May, 2022

Eight different food items including different wild grass seeds and grit were observed in the crop of male Red-billed quelea (*Q. quelea*) sampled for this study in the month of March. *Echinochloa colonum* was the most consumed food item with a mean of 31.03±3.12. Followed by *Digitaria ciliaris* with a mean of 33.01±1.07 and the least seed consumed for this month was *Cenchrus biflorus* with a mean of 1.03±0.09 as seen in table 2.

In the month of April, *Echinochloa colonum* was the most preferred food item by male *Q. quelea*, having the highest mean of 39.31±3.03, followed by *Digitaria ciliaris* with the mean of 38.21±0.13, while *Cenchrus biflorus* was again the least consumed food item, with the means of 13.00±2.01.

Echinochloa colonum was again the most preferred food item with the mean of 49.07±0.73, from the crop content of male *Quelea quelea* sampled in the month of May, which was followed by *Digitaria ciliaris* with the mean value of

39.13±1.21, while *Cenchrus biflorus* was also the least consumed food item, with the means of 16.05±1.02 as presented in table 2.

Table 3 Summary of the food Items observed in the Crops of Red-Billed Quelea Sampled from March - May

Food item	N	Total (%)	Mean ±SE	Min	Max
<i>Brachiaria mutica</i>	150	256(1.21%)	1.71±0.16	0	8
<i>Cenchrus biflorus</i>	150	173(0.82%)	1.15±0.02	0	13
<i>Digitaria ciliaris</i>	150	5366(25.40%)	35.33±1.03	0	107
<i>Digitaria iburua</i>	150	4503(7.59%)	29.96±1.12	7	56
<i>Echinochloa colonum</i>	150	6031(28.55%)	40.20±0.72	9	78
<i>Roetboellia exaltata</i>	150	3250(15.39%)	21.67±0.25	7	69
<i>Setaria pallidofusca,</i>	150	4402(20.84%)	29.33±0.41	3	72
Grit	150	23(0.11%)	0.15±0.36	0	3
Insect	150	19(0.09%)	0.13±0.15	0	1

P > 0.05

Table 4 Comparison of Grass Seeds in the Vicinity of the birds' feeding area, the top soil of birds' habitat, and birds' crops

Grass (seeds)	Vicinity of birds feeding area	Top soil of the birds' habitat	Birds' crops
<i>Brachiaria mutica</i>	+	+	+
<i>Cenchrus biflorus</i>	+	+	+
<i>Chloris pilosa</i>	+	+	-
<i>Dactyloctenium aegyptium</i>	+	+	-
<i>Digitaria ciliaris</i>	+	+	+
<i>Digitaria iburua</i>	+	+	+
<i>Echinochloa colonum</i>	+	+	+
<i>Eragorastis tremula</i>	+	+	-
<i>Eragorastis gangetica</i>	-	+	-
<i>Oryza barthi</i>	-	+	-
<i>Panicum sp</i>	+	+	-
<i>Roetboellia exaltata</i>	+	+	+
<i>Sacciolepis Africana</i>	+	+	-
<i>Setaria pallidofusca</i>	-	-	+
<i>Schoenefeldia gracilis</i>	-	+	-

Key + = Positive, - = Absent

3.3. Summary of the food Items observed in the Crops of Red-Billed Quelea (*Quelea quelea*) Sampled from the month of March - May 2022

Echinochloa colonum was the most consumed food item having the highest mean of 40.20±0.72, followed by *Digitaria ciliaris* with a mean of 35.33±1.03. While the least consumed food item is *Cenchrus biflorus* with the means of 1.15±0.02 as shown in table 3. Small quantity of insect remained was recovered in the crop of female Quelea birds (*Q. quelea*)

sampled for this period of study with the exception of the month of April. Grits was also recovered in the crop of both male and female Red-billed quelea (*Q. quelea*) sampled for this research work.

3.4. Comparison of Grass Seeds in the Vicinity of the birds' feeding area, the top soil of birds' habitat, and birds' crops.

When the top soil of the habitat of the quelea bird was cultured for seeds and sampling for grass seeds within the birds' vicinity; *Brachiaria mutica*, *Cenchrus biflorus*, *Chloris pilosa*, *Digitaria ciliaris*, *Dactyloctenium aegyptium*, *Digitaria iburua*, *Echinochloa colonum*, *Eragrostis tremula*, *Oryza barthi*, *Panicum sp*, *Roetboellia exaltata*, *Setaria pallidofusca*, *Schoenefeldia gracilis*, *Sacciolepis Africana* were found. It was observed in this study that most of the soil seeds reserved and grass seeds within the birds' vicinity were also found in the Quelea birds' crops. While *Setaria pallidofusca* is absent in both the birds vicinity and the soil seed reserves but found throughout the period of the study in the quelea birds crops.

4. Discussion

The finding of this research work shows that, the Red-billed Quelea (*Quelea quelea*) consumed nine food items including insects remained and grit in the month of March. The most preferred seed is *Echinochloa colonum*, having the highest mean value of 32.01 ± 4.02 in female and 34.03 ± 3.12 in male. This was followed by *Digitaria ciliaris* with a mean of 31.05 ± 1.04 in female and 33.01 ± 1.07 in male. While the least consumed seed for the month of March was *Cenchrus biflorus* with a mean value of 0.38 ± 0.73 in female and 1.03 ± 0.09 in male. Small quantity of grits was also recovered in both male and female Red-billed Quelea crops. Insects remained were recovered only in female Red-billed Quelea crops. The result of this study is in line with the findings of Ozolua (1986), who reported that grainvorous birds generally prefer wild seeds and tend to go for cultivated cereal crops when the grass seeds are in short supply.

In the month of April, eight different food items were consumed by the Quelea birds. *Echinochloa colonum* was the most consumed food item with the mean value of 38.27 ± 2.09 , 39.31 ± 3.03 female and male respectively followed by *Digitaria iburua* with the mean of 36.94 ± 3.15 in female and *Digitaria ciliaris* with the mean value of 38.21 ± 0.13 in male. The least consumed food item for this month was *Cenchrus biflorus* with the means of 11.03 ± 1.04 , 13.00 ± 2.01 in female and male respectively. The findings of this study therefore, agree with Erickson (1979), who reported that, there are naturally preferred foods of the Red-billed Quelea. The result of this month also shows no insect's remained in the crop of both female and male Quelea birds sampled. This is not in line with Yusuf *et al.*, (2004a) who stated that female birds are known to eat more animal food than males during pre-breeding for egg-making and during breeding to withstand the stress of brooding and for feeding their nestlings. This may be because April is not the month of reproduction (egg formation, incubation and chick rearing) of Quelea birds.

There are nine food items recovered in the crops of Red-billed Quelea in the month of May. *Echinochloa colonum* has the highest mean value of 41.03 ± 0.91 in female and 49.07 ± 0.73 in male; this was followed by *Digitaria ciliaris* with mean value of 40.16 ± 0.70 in female and 39.13 ± 1.21 in male. *Cenchrus biflorus* was the least consumed seed with the means of 13.02 ± 1.04 and 16.05 ± 1.02 in female and male respectively. The result of this study is not in line with Birdlife International (2014), who reported that the food of the Red-billed Quelea consists of grass seeds and grains. As only wild grass seed, few grits and insects remained were recovered in the crops of sacrificed Quelea birds (*Quelea quelea*) in this study, but no cultivated grains were encountered. This is not surprising however as this study was conducted during the off- cropping season. The result of this study concur with the findings of Erickson (1979), who reported that in the late dry season Quelea birds were feeding entirely on grass seed and there was no evidence of food shortage in the life of Quelea birds in Awash River Basin of Ethiopia. Brugger and Jaeger (1989), Robert *et al.* (2007), reported that wild annual grasses form the bulk of the diet of Quelea birds. This was also observed in this study, this suggests that, Quelea birds all over the sub-tropics, despite their taxonomic and geographical differences prefer wild grass seeds. The preference for *Echinochloa colonum* compared to other food items may be because it is more palatable. Quelea birds appeared not to like very tiny food items like *Cenchrus biflorus* and also very thick, hard- husk food items because they are difficult to de-husk, as reported by GTZ (1987). Quelea birds apparently avoided such seeds.

In this study it was observed that grits occurred in the bird's crops from March – May. This agrees with the findings of Yusuf *et al.* (2004c). Grits are necessary for birds generally because this help in grinding their food since birds do not have teeth. Grits are also a source of mineral salts such as calcium.

Small quantities of insect remains were among the crop contents of some female Quelea birds (*Q. quelea*) while males had no such food remains in their crops. This may be explained by the fact that female birds expend more energy than males in the reproductive process. The consumption of insects by females is vital to egg formation as well as the

accumulation of the body fats that are metabolized during incubation and chick rearing (Welty and Baptista, 1990; Yusuf *et al.* 2004c). Also Yusuf *et al.* (2004a) reported that female birds are known to eat more animal food than males during pre-breeding for egg-making and during breeding to withstand the stress of brooding and for feeding their nestlings.

It was observed in this study that most of the soil seeds reserved in the top soil were also found in the Quelea birds' crops. This has also been reported by other researchers like Ward (1965), Erickson, (1979), Yusuf *et al.* (2004b) and GTZ (1987). This implies that Quelea birds foraged within their vicinity if there is abundance of wild grass seeds, but in the absence of their preferred wild grass seeds, they may travel to distant places of 10km – 20km away from their night roost to forage (GTZ, 1987). *Setaria pallidofusca* was observed in the birds' crop but was absent in the top soil of the birds' habitat (soil seed reserved) as well as grass plants (seed) in the birds' vicinity. This was an indication that the birds not only foraged in their roost area where they were caught but also from other areas, as reported by GTZ, (1987).

5. Conclusion

In conclusion, the Red-billed Quelea (*Q. quelea*) can survive without cultivated crop seed (cereal), since it was observed that there are up to nine different wild food items the bird foraged on between March to May, 2022. The most preferred food items were *Echinochloa colonum*, followed by *Digitaria ciliaris* and the least consumed seed is *Cenchrus biflorus*. Small quantities of grits were observed in the crops of both male and female Quelea bird (*Q. quelea*), while insects remained were only observed in the crop of female *Q. quelea*. There is no significant difference between the food items foraged on by the Red-billed Quelea (*Q. quelea*) at $P > 0.05$ during the study period. But there is significant differences between the food items foraged on by the male and female Red-billed Quelea (*Q. quelea*) at $P < 0.05$, when compared by sex.

Based on the findings of this research work, the researchers therefore proffer the following recommendation:

- That further studies should be carried out during cropping season to find out the food items foraged on by Red-billed Quelea (*Q. quelea*).
- That further studies should be carried out on biological control of Quelea birds (*Q. quelea*).

Compliance with ethical standards

Acknowledgments

Our most profound gratitude goes to Tertiary Education Trust Fund (TETFund) for funding this research work under the project with ID No. TETF\DR&D/CE/UNIV/MUBI/IBR/2019/Vol.1. We wish to appreciate the Management of Adamawa State University, Mubi, for its critical administrative role that ensures the successful disbursement of the fund to us. The authors also wish to thank the people of Gyawana Community for allowing us have access to their land and for their assistance during data collection which made this work lighter. Our sincere gratitude goes to Dr. Augustine Clement for his words of encouragement and guidance that led to the success of this research.

Disclosure of conflict of interest

The authors declare no conflict of interest.

References

- [1] Oschadleus, H.D. Red-billed Quelea Movement in Southern Africa shown by ringing recoveries in the Safring database. Workshop on Research priorities for migrant pests of Agriculture in Southern Africa. (eds) R.A., Cheke, L.J. Rosenberg and M.E. Kieser. 2000, pp. 125-138.
- [2] Safford, R.J. Red-billed quelea (*Quelea quelea*) In. The birds of Africa, vol viii: The Malagasy Region, [ed by Safford R.J. Hawkins AFA] London, UK; Christopher Helm. 2013, 873-874
- [3] Craig, A.F.J.K. (2010). Family ploceidae (weavers) Weavers to new world wablers. In Handbook of birds of the World [ed by Hoyo J.D., Elliott, A., Christie, D.A] Barcelona, Spain, Lynx Edicions, 2010, (15) 74-97
- [4] BirdLife International (2013). Bird trade Red billed quelea Guide
- [5] Borello, W.D., Cheke, R.A. Fidelity to non-breeding ground by migrant Red-billed quelea (*quelea. Quelea Lanthamii*) in Botswana. The Babbles 2001, 56:11-14

- [6] Borrow N. and Demey R. Birds of Western African. Christopher Helm, London. 2001, pp. 147 – 149.
- [7] Oschadleus, H.D. First Red-billed Quelea breeding record in the winter rainfall region of south Africa. BirdLife South Africa 2015, 573-575
- [8] Cheke, R.A., Venn, J.F. and Jones P.J. Forecasting suitable breeding conditions for the Red-billed Quelea, *Quelea quelea* in Southern Africa. Journal of Applied Ecolog. 2007, 44: 523-524.
- [9] Robert, A. C., Jon, F. V and Jones, P. J. Forcasting suitable breeding conditions for the Red-billed Quelea, *Quelea quelea* in Southern Africa. Journal of Applied Ecology, 2007, 44: 523-533.
- [10] Elgood, J.H. Birds of the West Africa Town and Gardens. West African Nature and hand books. Wash Cheong Printing Press, Hong Kong, 1982, p. 61.
- [11] Lioyd, P. Queleas. African Birds and Birding, 1999, 4: 52-61.
- [12] GTZ, Ecology and control of Red-billed weaver bird (*quelea quelea*) in Northeastern Nigeria. GTZ hand book no 199, Eschborn, 1987, pp1-241.
- [13] Jones, P.J. Dallimas, M., Cheke, R.A. and Mundy, P.J. Are there two sub-species of Red-billed Quelea, (*Quelea quelea*) in Southern Africa? Ostrich, 2001, 73: 36-42.
- [14] Dallimer, M., Jones, P.J. Pemberton, J.M. and Cheke, R.A. Lack of genetic and Plumage differentiation in the Red-billed Quelea, *Quelea quelea* across a migratory divide in Southern Africa. Molecular Ecolog. 2003, 12:345 – 353.
- [15] Walter, H. (1971). Ecology of Tropical and Subtropical Vegetation. Oliver and Boyd Edinburgh, London.
- [16] Cheke, R.A. An indigenous trap for mass capture of red-billed quelea. Bulletin of the British Ornithologist Club. 2011, 131:74.
- [17] Ward, P. Feeding Ecology of the Black-faced Dioch (*Quelea quelea*) in Nigeria. Ibis, 1965, 107: 326-349.
- [18] BirdLife International (2004). *Quelea quelea*. International Union for the Conservation of Nature (IUCN).
- [19] Bernitz Z. Feeding behavior of Lesser spotted eagle *Aquila pomarina* at *Quelea quelea*. *Quelea* colony in the Kruger National Park Gabar, 2010, 21:60-63.
- [20] Carina, L., Kany, T., Grashorn, M.A. Method to estimate feed intake from pasture in broilers and laying hens, European Poultry Science. Archiv fur Geflugelkunde, 2013, 77: (3)160-165.
- [21] Erickson, W.A. Diets of the Red-Billed *Quelea quelea* in The Awash River Basin of Ethiopia. In: Wildlife Management Internet Center for Bird Control Seminars Proceedings. University of Nebraska Lincoln, 1979, pp. 185 – 2000.
- [22] Ezealor, A. U. and Giles, R. H. Wintering Ruffs *Philomachus pugnax* are not Pests of rice *Oryza* spp in Nigeria's Sahelian Wetlands. Wildfowl 48: 202-209. Hartley, P.H.T. (1984). The Assessment of the Food of Birds. Ibis, 1997, 90:361-381.
- [23] Anonymous, *Quelea* birds invade Seven Local Government Areas in Kano State. In Weekly Trust Friday, August, 2001, 24, 2001. P16.
- [24] Cheke, R.A., .Adranyi, E., Cox, J.R., Farman, D.I., Magoma, R.N., Mbereki, C., Mcwillian, A.N., Mtobesya, B.N., Walt, E. Soil contamination and persistence of pollutants following organophosphate sprays and explosions to control Red-billed quelea (*quelea. Quelea*). Pest Management Science 8th European Vertebrate Pest Management Conference, Berlin Germany. 2013, 69:(3) 386-396.
- [25] Audu, O. (2017) Nigeria spends two hundred and twenty six million naira to forestall quelea birds' epidemic. Oak TV, 2017.
- [26] Kazaure, A. (2019). Federal Government Intensifies aerial spray on *Quelea* bird in North East. News Agency of Nigeria (National) September 1st, 2019.
- [27] Muhammad, A.R. (2019). Sokoto farmers lost battle with quelea birds. Daily Trust. August, 20- 2019.
- [28] Adebayo, A.A., Onu, J.I., Adebayo, E.F. and Anyanwu, S.O. Farmer's Awareness, Vulnerability and Adoption to Climate Change in Adamawa State, Nigeria. British Journal of Arts and Social Science, 2012,9(2): 106- 115.
- [29] Kirkpatric, R.L., Fontenot, J.P., and Harlow, R.F. Seasonal changes in rumen chemical components as related to forages consumed by white-tailed deer of the southeast. Trans North Am. Wildlife Nat. Resource Conference, 1969, 34:22-23.

- [30] Jonathan, B.H. and Frederich, A.S. Techniques for Wildlife nutritional analysis. (ed.) Theodore, A.B. Research and Management Techniques for wildlife and habitats. Fifth ed. The Wildlife Society Bethesda, Md. 1994, p 317.
- [31] Buij, R. Pallid Harrier *circus macrourus* bird hunting behavior and capture success in northern Cameroun Ostrich. *Journal of African Ornithology*. 2012, 83:(1) 27-32.
- [32] Buba, Z.M., Ezealor, A.U., Balarabe, M.L., David, D.L. and Midau, A. Evaluation of Wild Diet for Red-Billed Quelea (*Quelea quelea*) in Sambisa Game Reserve and its Environs, Borno State, Nigeria. *European Journal of Biological Sciences*, 2013, 5(4): 117-122, 2013.
- [33] Yusuf, S.D, and Bello, Z.M. The crop and Gizzard food contents of Purple Glossy Starling (*Lamprotornis purpureus*) in Jere and Konduga Local Government Area of Borno State, Nigeria. *International Journal of Agriculture and Biology*, 2004a, 6:(2) 270-271.
- [34] Yusuf, S.D., Yakubu, Y. and Madziga. B. The Food of Quelea Birds *Quelea quelea* during the dry season in Borno State, Nigeria. *Pakistan Journal of Biological Sciences*, 2004b, 7:(4) 620-622.
- [35] Ozolua, K. (1986). Bird Menance to Crops and its control. A paper presented at a two week National Workshop; on post-harvest food losses and their control; organized by Center for Rural Development and Co-operatives, April 14-25, University of Nigeria, Nsukka.
- [36] BirdLife International (2014). *Quelea quelea*. International Union for the Conservation of Nature (IUCN).
- [37] Brugger, R.L. and Jaeger, M.M. (1989). Bird Pests and crop protection strategies for cereal of the semi-arid tropics. (ed) Doggett, H, In: *Sorghum UK*, Longman Publisher pp.
- [38] Yusufu, S.D; Biu, A.A. and Buba, G. *Quelea* Birds (*Quelea quelea*): A Correlation Study between feeding habit and gastro-intestinal parasitism in Borno State, Nigeria. *International Journal of Agriculture and Biology* 2004c, 6:(2) 268.
- [39] Welty, J. C. and Baptista, L. (1990). *The life of birds*. Saunders College Publishing. p. 581.