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**A Study on Some Biological Aspects of Dorcas gazelle
(*Gazella dorcas*) under captive conditions**

دراسة بعض الجوانب البيولوجية للغزال الدوركاس تحت ظروف الأسر

By

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DEDICATION

To my parents, dear father and mother for their suffering to bring me up, their great efforts to help me to complete this work. I also dedicate this humble work to my lovely brothers, sisters, friends and colleagues in the wildlife field.

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Praise in the first place is to my lord (Allah) for giving me health, strength and power to complete this study. I would like to express my heartfelt gratitude to my supervisor professor/Ali Saad Mohamed for his endless guidance and for sacrificing his time to read my work. I am extremely grateful for his tireless support, advices and suggestions from the beginning to the end of this study.

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ABSTRACT

The present study was conducted during the period (15th February to 30th March 2018) at Kuku Zoo Animal to determine the morphological characteristic ,food preferences on some selected common food stuff and observations of daily activities on captive Dorcas gazelle (*Gazella dorcas*),.

Seven pairs (7male and 7female) of Dorcas gazelle were divided into two groups; five adult pairs between the age (26 – 108 months) and two juvenile pairs (4 – 9 months). The animals were accommodated in seven separate enclosure pens with dimensions: 6m. ×2.8m. ×3m constructed with iron rails. The morphological measurements of different parts of the body for adult gazelle were: body weight (12.52±2.66kg), horns length (30.4±8.95cm), total length (91.4±12.22cm), fore-limbs length (59.5±5.48cm), hind-limbs length (72.3±6.60cm), facial length (20±2.58cm), shoulder height (50.3±4.76cm), ear length (20.2±1.81cm) and tail length (23.4±2.88cm) for both adult male and female. The juvenile gazelles measurements were: body weight (6.38±1.93kg), horns length (11.75±5.56cm), total length (70±19.11cm), fore-limbs length (46.5±9.57cm), hind-limbs length (55±8.45cm), facial length (16.75±4.99cm), shoulder height (38.25±9.60cm), ear length (11.75±2.22cm) and tail length (17.25±1.83cm) for both male and female

Two adult pairs (2males and 2females) of Dorcas gazelle were accommodated in separate enclosure pens with dimensions: 6m. ×2.8m. ×3m constructed of iron rails. The animals were rationed in different foodstuff; Alfalfa (*Medicago sativa*), Sorghum (*Sorghum vulgare*), common wheat bran (*Triticum aestivum*), and Sorghum straw (*Sorghum bicolor*) over a period of fifteen days to determine the animals food preference and daily feed intake. Sorghum (*Sorghum vulgare*) was highly

preferred diet with intake $643\pm 219.66\text{g/day}$; while Abu 70 (*Sorghum bicolor*) feed was the least preferred with intake $141.3\pm 52.55\text{g/day}$ from diets offered to Dorcas gazelle in captivity.

The behavior under captivity was observed in four Dorcas gazelle (26, 36, 60, 108 month) old. Different behavior pattern were observed such as; lying down, standing, pacing/walking, eating, ruminating, playing, Romancing & Mating, drinking, defecating and urinating. Lying down was the dominant activity, especially during the night with rate 48.56% followed by standing, pacing/walking, eating, ruminating, playing, Romancing & Mating, drinking, defecating and urinating with rate 15.42%, 11.61%, 10.42%, 9.95%, 3.36%, 0.23%, 0.19%, 0.17%, 0.09% respectively.

ملخص الاطروحه

أجريت هذه الدراسة خلال الفترة (١٥/فبراير - ٣٠/مارس/٢٠١٨م) بحديقة حيوان كوكو لتحديد الصفات الشكلية، تفضيلية بعض المواد العلفية الشائعة في الغذاء ومراقبة النشاطات اليومية للغزال العادة (غزال الدوركاس) في الأسر.

سبعة أزواج (٧ذكور و٧إناث) من الغزال العادة قسمت لمجموعتين؛ خمسة أزواج بالغة (26 - 108 شهر) وزوجين يافعين (4 - 9 شهر) أسكنت في سبعة مجموعات منفصلة الأقفاس بالأبعاد 6م x 2.8م x 3م مشيدة من القضبان الحديدية . كانت القياسات الشكلية لأجزاء الجسم المختلفة للغزال البالغ: وزن الجسم (2.66±12.52سم)، طول القرون (8.95±30.4سم)، الطول الكلي (12.22±91.4سم)، طول الأطراف الأمامية (5.48±59.5سم)، طول الأطراف الخلفية (6.60±72.3سم)، طول الوجه (2.58±20سم)، إرتفاع الكتف (4.76±50.3سم)، طول الأذن (1.81±20.2سم)، طول الذيل (2.88±23.4سم) لكل من الذكور والإناث البالغة. بينما القياسات للغزال غير البالغة كانت: وزن الجسم (1.93±6.38سم)، طول القرون (5.56±11.75سم)، الطول الكلي (19.11±70سم)، طول الأطراف الأمامية (9.57±46.5سم)، طول الأطراف الخلفية (8.45±55سم)، طول الوجه (4.99±16.75سم)، إرتفاع الكتف (9.60±38.25سم)، طول الأذن (2.22±11.75سم)، طول الذيل (1.83±17.25سم) لكل من الذكور والإناث.

أسكن زوجان (2 ذكور و 2 إناث) من الغزال العادة البالغة في أقفاص مختلفة بالأبعاد: 6م x 2.8م x 3م مشيدة من القضبان الحديدية، وتم إختبار التفضيلية الغذائية لعدد أربعة مواد علفية؛ البرسيم (*Medicago sativa*)، الذره (*Sorghum vulgare*)، ردة القمح (*Triticum aestivum*)، وأبوسبعين (*Sorghum bicolor*). لفترة خمسة عشر يوماً. كانت الذرة *Sorghum Vulgare* كأعلى تفضيلية بمعدل تناول 219.66±64 كجم/اليوم بينما عليقة أبو سبعين *Sorghum bicolor* كأقل تفضيلية بمعدل تناول 141.3±52.55 كجم/اليوم من بين العلائق التي قدمت للغزال العادة في الأسر.

تم مراقبة سلوكيات الغزال العادة تحت ظروف الأسر لاربعة غزالان عمر (26، 36، 60، 108 شهر) رصدت أنماط السلوكيات المختلفة مثل: الرقاد، الوقوف، المشي/التحرك، الأكل، الإجتار، اللعب، المغازلة/السفاد، الشرب، التغوط والتبول. كان الرقاد النشاط السائد خصوصاً في فترات الليل بمعدل 48.58% ويليه الوقوف، المشي/التحرك، الأكل، الإجتار، اللعب، المغازلة/السفاد، الشرب، التغوط والتبول بمعدلات 15.42%، 11.61%، 10.42%، 9.95%، 3.36%، 0.23%، 0.19%، 0.17%، 0.09% على التوالي.

CHAPTER I

1. INTRODUCTION

Biodiversity is rapidly decline globally. Out of the 61,898 taxa are listed by (IUCN, 2010). 35.9% are either extinct with (0.1%) in the wild. According to IUCN (2014) the critically endangered were (7.4%), endangered (11.0%) and vulnerable (17.4%). 22.1% of the threatened animals are mammals including large herbivorous species (IUCN, 2014).The dorcas gazelle (*Gazella dorcas*) is the smallest gazelle species, and formerly, was the most common throughout most of North Africa. Although defined as a typical desert and semi-desert plains species, it occupies a variety of habitats within its wide area of distribution, from the Sahel to the Mediterranean Sea, and from the Atlantic coast to the Red Sea (Baharav and Mendelsohn, 1976; Kacem *et al.*, 1994; Mallon and Kingswood, 2001; Chammem *et al.*, 2008). Gazelles are distributed across Africa and Asia and adapted to arid and semi-arid environments (Lerp, *et.al.*, 2013). Dorcas gazelles occur throughout North Africa, Middle East and South of the Sahara westward from the Red Sea. They ranges across northern Africa from Rio de Oro, Morocco, Algeria, Tunisia, Libya and Egypt, south to the Sudan, northern Ethiopia, Somalia, and Chad in Africa and is found in Sinai and Palestine (Ellerman and Morrison-Scott, 1951 and Groves, 1981). It is distributed also through Mauritania and across the Suez Canal into Asia, as far south as Yemen and as far to the east as the western shores of the Arabian Sea (Husam, 2003). Around Palestine in the Negev desert Dorcas gazelles are better adapted to the environment than other grazing animals (Yom-Tov, *et.al.*, 1995). They compete with other grazers that are used for economic purposes such as sheep and goats. Dorcas gazelles were considered by José, *et.al.*, (2011) as the North African gazelles. Dorcas gazelle is a small and common gazelle (Ahmed, *et al.*, 2012); it has face length 25 cm, ear length 7 cm, forelimb length 55 cm, hind limb length 59 cm and tail length 10 cm, Dorcas gazelle stands approximately 55–

65 cm and have ahead and body 90–110 cm length and a weight of 15–20 kg their body dimensions vary considerably. Body is covered with a thick layer of hair measures from 0.5-3.5 cm in length and is especially long on the neck. The mating season in the wild start on September-November (Ward and Saltz, 1994). Many factors are contributing to the decline of population sizes of antelopes including illegal hunting, habitats destruction and competition with livestock and growing and developing human population (Sokolov, *et. al.*, 1982). All the above factors led to breeding some species of wild animals in farms to conserve them from extinction so that the present and future generations could enjoy watching captive animals. Arabs reared gazelles as pet animals both in rural and urban settling. Their parts are also used in other functional ways. Hides of gazelle used to construct a litter called (Dhalls) for wives and daughters of tribes men. Little is known about Dorcas gazelle's ecology in Africa, as it has been the object of limited research (Ghobrial, 1974; Newby, 1974; Essaghier, 1981). Lack of technical information on Dorcas gazelle diet's and daily activities in captivity may affects the income of private wildlife farms and zoos which depend occasionally on the technical supports for feeding gazelles kept in enclosures (Sayied, 1999).

Objectives

Overall objective

The aim of this study is to collect information about Morphological measurements, Food preference and daily activities of Dorcas gazelle under captive condition.

Specific objectives:

1. To determine the average morphological measurements of Dorcas gazelle.
2. To verify the food preference of dorcas gazelle on selected common foodstuff in captivity.
3. To study some behavioral traits of dorcas gazelle under captive conditions

CHAPTER II

2. LITERATURE REVIEWS

2.1. Classification of Dorcas gazelle (*Gazella dorcas*)

According to O'Regan, (1984); Corbet and Hill, (1986) and Groves, (1988) Dorcas gazelle *Gazella dorcas* categorized belonging to the Tribe Antilopini, family Bovidae, Subfamily Antilopinae, which comprise many genera such as *Gazella*, *Antilope*, *Procapra*, *Antidorcas*, *Litocranius* and *Ammodorcas*. The genus *Gazella* include one extinct species and ten to fifteen surviving species. Groves, (1996 and 1997) distinguished seven species of the genus *Gazella* as follows: *Gazella dorcas*, *Gazella saudiya*, *Gazella gazelle*, *Gazella Arabica*, *Gazella bilkis*, *Gazella benneettii*, *Gazella subgutturosa*. Dorcas gazelle *Gazella dorcas* has several subspecies that are described on the basis of phenotypic variation, such as coat coloration and horn shape and length (Groves 1969, 1981; Alados 1987; Yom-Tov, *et.al.*, 1995; Groves and Grubb, 2011 and José, *et. al.*, 2011). A phylo-geographic study based on sequence variation of the mitochondrial cytochrome b gene and control region recently indicates that *G.dorcas* including '*G.saudiya*' and '*G.pelzelni*' represent a reciprocally monophyletic group with a sister-group relationship to *G. gazella* and *G. arabica* (Lerp, *et. al.*, 2011). Smith, *et.al.*, (1997) described the Dorcas gazelles belonging to subfamily Antilopinae or true gazelles, including: Thompson's gazelle (*Gazella thomsonii*), Grant's gazelle (*G. granti*), Dorcas gazelle (*G. dorcas*), Dama or Mhorr gazelle (*G. dama*), Somemmering's gazelle (*G. sommeringi*), Speke's gazelle (*G. spekei*), Slender-horned gazelle (*G. leptoceros*), Goitered, Persian or Arabian sand gazelle (*G. marica* subs), Cuvier's gazelle (*G .cuvieri*), Gerenuk (*Lithocranius walleri*), Springbok (*Antidorcas-marsupialis*), Black buck (*Antilope cervicapra*) . The authors also reported that Dorcas gazelles were among the Order Artiodactyla,

Suborder Ruminantia, Family Bovidae, and Subfamily Antilopinae (Yom-Tov, *et al.*, 1995). The genus *Gazella* currently contains numerous species, and may be polyphletic. There are seven subspecies were recognized by Groves, (1981): *Gazella dorcas dorcas* (Linnaeus,1758) *G. d. massaesyla* (Cabrera,1928; Synonym is *cabrerae*), *G .d. osiris* (Blaine, 1913; Synonym *neglecta*). *G. dorcas- isablla* (Gray, 1846; *Isidis* and *littoralis* are synonyms), *G .d. beccarii* (de Beaux, 1931) and *G. d. pelzelni* (Kohl, 1886) on the inclusion of *G. pelzelni* in this species (Groves, 1985).Dorcas gazelles of the Sinai Peninsula, were reported, belong to the subspecies *G. d. saudiya* (Ellerman and Morrison-Scott, 1951; Harrison, 1968; Osborn, and Helmy, 1980). However, Ferguson (1981) concluded the Dorcas-gazelle of the Mediterranean maritime plains of Sinai belong to the subspecies *G. d. dorcas*, while those of the littoral of the southern Sinai belongs to subspecies *Gazella. d. Isabella*.



Figure 1: Adult male and female Dorcas gazelle

(saharaconservation.org)

2.2. Ecology and Habitat of Dorcas gazelle

Husam, (2003) observed grasslands, shrub lands and semi-deserts are the main habitats used by Dorcas gazelles throughout their range. d. gazelle has been observed to prefer Wadies dominated by *Acacia* sp. during the dry season and upland habitat during the cold season (Newby, 1974; Baharav, 1980), and inhabits a wide range of arid and semi-arid regions, but avoids extensive areas of dunes and hyper arid areas (Cuzin, 2003; Lafontaine, *et.al.*, 2005). Henley, *et.al.*, (2007) reported no significant relationship between habitat selection and plant species distribution by the dorcas gazelle. The author observed this species living in a variety of habitats such as; Savannahs, Semi-desert, small sand dunes, field consolidated dune area, Wades and associated with a number of different plant species. High densities of this gazelles were found in sand dune fields with high concentrations of *Madona lilies*, which is preferred food for gazelles in the Negev desert (Lawes and Nanni, 1993; Ward and Saltz, 1994). Lafontaine, *et.al.*, (2006) explain that the dorcas gazelle inhabit grassland and steppe in Morocco while in Algeria inhabit the desert, sub-desert and steppe . In Libya they occur in a range of dry open habitats; but show strong preference for vegetated dry water resources, known as Wades (Essaghaier,1981).According to Osborn and Helmy (1980) the dorcas gazelle in western desert of Egypt, it prefers Oasis-type depressions that used to occur along the coast of the Mediterranean, it also inhabits wades in this area. In Jordon they are found in flat gravel-plains, mixed gravel and dune areas and gravel plateau (Mallon and Kingswood, 2001). It can be found throughout the Sahara and Sahel, but tends to avoid very sandy areas or true deserts (Osborn and Helmy, 1980; Kacem, *et al.*, 1994).

2.3. Distribution and Conservation Status of Dorcas gazelle

According to Groves, (1996 and 1997) the distribution of the dorcas gazelle were: *Gazella dorcas* found in North Africa, northern Somalia ,Ethiopia,

Sinai and southern Palestine , *Gazella saudiya* found in Saudi Arabia, Kuwait and southern Iraq. *Gazella gazella* is confined to Palestine, Lebanon and Arabian Peninsula; those countries south of the borders of Saudi Arabia with Iraq, Kuwait and Jordan. *Gazella arabica* is found in Farasan Island in the Red Sea. *Gazella bilkis* is found in Yemen. *Gazella benneettii* is mainly found in Iran, Pakistan and India. *Gazella subgutturosa* is found in Arabian Peninsula, Bahrain and Jordan. Pfenniger and Schwenk, (2007) studied the distribution of the Dorcas gazelle in Savannas, semi-desert and true desert throughout northern Africa and western Arabia. According to East, (1999) this gazelle formerly occurred over the entire Sahel-saharan regions from the Mediterranean to the Sahel and from Atlantic to the Red Sea, and extending into Southern Palestine, Syria and Jordan (marginal occurrence). Ghobrial (1967) said that the d. gazelle distributed from Northern Nigeria, Niger, Chad and the Sudan mainly on the Western side and were widely distributed in Arabian Desert (Uerpmann, 1986). Dorcas gazelle well distributed throughout the desert and sub-desert zones of central and Northern Sudan, from Chad and Libya to the Red Sea in 1980s its remained widely distributed but in ever fragmented and greatly reduced population (Newby,1981; Hillman and Fryxell, 1988). Dorcas gazelles are thought to exist in a wide variety of habitats from Sahelan savannahs to semi-arid gravel and sand deserts, while avoiding hyperacid areas and the upper elevations of the central-Saharan massifs (Dorst and Dandelot, 1972 Haltenorth and Diller, 1980 and Wachter, *et al.*, 2004). Dorcas gazelles distributed from Morocco and Mauretania in the west to the Horn of Africa in the east, and also occurred on the Sinai Peninsula (Dorst and Dandelot, 1972 and East, 1999).According to East (1988; 1990) distribution of dorcas gazelle in Africa extends south as far as the mid-Sudan, Chad, Niger, and Mali. East (1996) said that occurrence of dorcas gazelle in Nigeria is very doubtful and it is considered extinct in Senegal. According to IUCN (2000) dorcas gazelle was assessed as vulnerable.

Generally, large mammals are seriously threatened in North Africa (Godinho, *et.al.*, (2012) with emblematic cases of extinction reported during the twentieth century, so, *G. dorcas* is an endangered species whose populations drastically declined in the last few decades. According to (IUCN, 2003) poachers are the main threatens to dorcas gazelle. It is also reported as vulnerable by Species Survival Commission of the World Conservation Union (IUCN, 2010). Numbers of *Gazella dorcas* had been decline for some time mainly due to hunting (East, 1999; Mallon and Kingswood, 2001 and Lafontaine *et al.*, 2006). Decline in all range states and their disappearance from many regions was due to a seriously reduced numbers where they survive (Lafontaine, *et. al.*, 2006). IUCN (2010) reported Dorcas gazelles face high risk of extinction in the wild. Threats facing this species include; habitat losses due to expansion, permanents agriculture and grazing pressures caused by domestic sheep and goats, poaching for food and predation by dogs are also other problems. But the most serious threats throughout this gazelles range uncontrolled illegal hunting (Mallon and Kingswood, 2001). According to Ghobrial (1967) the distribution of docas gazelle in the Sudan are common in Darfur, Kurdofan, Dongola and Kassala and the area in which they occur can be divided into three regions, Desert, Semi-desert and Savannah, regarding the vegetation cover of these three regions. This species still occurs in the desert of Northern Sudan (Hashim, 1996). The distribution of Dorcas gazelles in Sudan reported by Sayied (2004) as small groups of Dorcas gazelles that had lived in Bayyodah desert around Dongola town and in the area extending from Wadi-Halfa to Abu-Hamad; in White Nile States there was small groups of Dorcas gazelles survive in Al Baja- desert area. In Khartoum State the author reported Dorcas gazelles that found in few groups in West of Omdurman; moreover in Northern Kurdofan and Southern Darfur States this gazelles found in various areas. This gazelles were distributed in Red Sea, Khartoum, Kurdofan and Darfur States

(Nimir, 2001). Conservation Status of *Gazella dorcas* in the Sudan was considered as vulnerable or probably near to threatened in the Sudan (Nimir, 2001). Hunters take advantage of gazelle concentrations during migration to kill them in large numbers and this gazelle in 1970s had disappeared from most of the North-western of the country (Ghobrial, 1974). According to Nimir (1983), it had been declined considerably in recent decades due to uncontrolled hunting (poaching) and degradation loss of habitat due to livestock over-grazing and agricultural encroachment. The presence of *Gazella dorcas* in the Red Sea, North and Western of Sudan, either in Khartoum State especially in western part of Omdurman was reported by Nimir, (2001) who draws the attention to their numbers which were declined as result of poaching. Sayied, (2004) reported this species in the White Nile States that have completely disappeared except in a very small area where limited groups of gazelles still live due to agricultural extension since the sixties of the last century. Wild populations of dorcas gazelles are experiencing a drastic reduction in most of their distribution due to illegal hunting. Human activities, e.g., livestock grazing, agriculture and settlement around new wells, reduce the space available for this species, and social conflicts and political instability in some areas of its distribution reduce their probabilities of natural recovery (Mallon and Kingswood, 2001; Chammem, *et.al.*,2008). The dorcas gazelle is globally classified as “Vulnerable” (IUCN,2011), but its status differs from country to country, from “extinct” in Senegal to “endangered” in Morocco or Tunisia to “vulnerable” in Algeria (Mallon and Kingswood, 2001).

2.4. Morphological Characters of Dorcas gazelle

Groves (1996) said that all member of this species have rather long hind limbs compared to the forelimbs. Yom-Tov, *et. al.*, (1995) reported that forelimbs are longer compared with hind limbs in some subspecies. The authors also described the color as a light sandy-brown and the lateral stripe is inconspicuous,

but the facial pattern is well developed. The light supraorbital stripe is almost white, and the tail is long, (about 12.1 cm). Groves, (1985) and Groves and Lay, (1985) reported *Gazella dorcas* as the smallest living species of the genus *gazella*. Compared with its close relatives, *G. gazella*, *G. dorcas* are smaller (Groves, 1985). The Saharan subspecies of Dorcas gazelle are very pale fawn, with a brown stripe bordering white of the underside, and a paler sandy stripe above it; forehead and mid-face are slightly darker than the body (Yom-Tov., *et. al.*, 1995). Description of Yom-Tov., *et. al.*, (1995) included the dark facial stripes that are blackish, the mid facial tone is dark chestnut, the light face-stripes have a yellow tone, and there generally no nose-spot and there is a black spot on the bridge of the nose in some individuals. Husam, (2003) described the general colour of *Gazella dorcas*, which is pale sandy fawn, with a faint rufous-fawn band along the lower flank contrasting with the white belly. He mentioned there is a rufous-fawn band on the blaze and a brownish-fawn stripe from eye to mouth, (a white band) which runs from the base of the horn to the upper lip separates these. There are long tufts of rufous-brown hairs on the knees of the forelegs, and a white patch on the rump. Both sexes have horns, which are medium in length, lyrate, strongly ringed, curved backwards and those of females are shorter (15-25 cm), straighter and less curved and with fewer ridges (Dorst and Dandelot, 1972; Kingdon, 1990). AMDB (2004) and SSA (2011) reported that this small gazelles has a very pale fawn colored coat the white underside bordered with brown stripe, above which there is a sandy stripe. The authors also described the forehead and face as darker than the body and well-marked dark lines from eyes to nostril between those two lines, a white stripe extends from upper lip to horn base. According to the description mentioned by Groves and Lay, (1985) the horn are more compressed and have 20-24 close-setrings in males and also the horns of female's are relatively strong, long, and ringed. According to Yom-Tov, *et. al.*, (1995) horns are present

in both sexes and male's horn being longer about 25-28cm and thicker, horn lyre shaped' strongly curved which bow outwards then turn inwards and forwards at the tips; the horns of the female are straight or slightly lyre-shaped in frontal view, 17-19 cm long, and usually with 16–18 more or less conspicuous rings. The authors said that female horns continue to grow until about the third year, but horn growth slows down after one and a half years of age and more so after the third year. AMDB, (2004) and SSA, (2011) mentioned that female's horns are shorter and straight, the horns may have up to 25 annular rings, (the horn length 25-38 cm). Moreover, the horns in male's varies from 26.6 cm in Somalia to 20.1 cm in Tibesti (in Tunisia) and the horns length in female's averages only 62% of the males in Somalia but nearly 80% in Sahara (Groves, 1981). Groves (1996) reported the average weight of this Gazelles are 14-20 kg and 9.2-18 kg in males and females respectively while mass mean and range of measurements of males in Palestine, Sinai, and the Red Sea Hills of the Sudan are 16 kg, but reach 19 kg in northern Chad (Oboussier, 1974). Yom-Tov, *et.al.*, (1995) reported the average weights are 16.5 in males and 12.6 in females. The weights recorded by Husam, (2003) and AMDB, (2004) are about 15-20 kg. It is a small gazelle with no sharply contrasted pattern on the body. Ears are long 12.9-17 cm in male and 13.5-16 cm in females and normally carried slanting laterally, but prick up when the gazelle is tense (Yom-Tov, *et al.* 1995). The author recorded the average head and body length of *G. dorcas* from Palestine, Sinai, and Sudan as 95.2 cm in females and the total length are 91-111cm in males and 88.5-114 in females (Groves, 1996). AMDB, (2004) and SSA, (2011) reported the total length are 90-110cm and the tails are 15-20 cm long. According to Yom-Tov, *et. al.*, (1995) the tail is 15 cm long. Groves, (1996) measured the tail length as 11.5-19 cm in male and 10.4-17 cm in females. Description in the Sudan stated this gazelles as desert colored (Ghobrial, 1967); the body is fawn with distinct lateral lines dividing the upper darker parts from the

white belly, the tail is black, the horns protrude from the center of the head and their point's coverage toward each other, the inward convergence doesn't show so much. According to Mohamed (2014) the means length of face is 14 cm, ear length 17 cm, fore limb length 53 cm, hind limb length 64 cm and tail length 18 cm, Dorcas gazelle stands approximately 55–65 cm and have ahead and body 81 cm length and a weight of 13 kg.

2.5. Behaviors of Dorcas Gazelle

2.5.1. Natural Habitat Behavior

Ward and Saltz (1994) reported the activity patterns of dorcas gazelle. The authors reported that at hot summer in Negev, the Dorcas desert gazelle are mostly active at dawn and dusk and in milder temperature the desert gazelle can be active all the day. The social behavior of Dorcas gazelle was studied by Newby, (1974) who considered dorcas gazelle *Gazella dorcas* nomadic and exhibit relatively small scale movements in response to the availability of pasture within some geographical region. Depending on the climate Ward and Saltz, (1994) observed the movement of this species as they can travel in pairs or larger group consisting of 1-2 males with a harem of up to 4 females with their young. The author reported that sometime males will travel in bachelor groups of 4-5 but, in extreme climates where resources are scarce. Yom-Tov, *et. al.*, (1995) measured the average territory size in the wild to reach 25 km² in areas rich with food. The males have regular territories and defend females. Daily activity of *gazelle dorcas* in the Sudan is determined mainly by the climate. In summer they are active during the early morning (05:00-08:00) and the evening (16:00-18:00), whereas in winter they may be active all day long provided the ambient temperature is not high. During the mid-day in summer they rest while either standing or lying in the shade of *Acacia* trees or bushes. On cold and windy nights they lie in shallow depressions dug with their feet in places protected by rocks or bushes, but also in the open if no

such places are available (Ghobrial, 1974). Gazelles in the Sudan migrate in summer from the west to the Nile Valley (Ghobrial and Cloudsley-Thompson 1976). The gazelles inhabiting the region of the Red Sea hills migrate to the coastal plain of the Red Sea in winter, both migrations reflect the need for water and food (Ghobrial, 1974).

2.5.2 Captive Behavior

The general activity observed on captive Dorcas gazelles in Khartoum Zoological Garden was mentioned by (Ghobrial, 1967). The author reported that gazelles are most active between 6:00 and 10:00 am, and seen lying down in the sun. During summer, maximum activity is between 5:00 to 8:00 am and the animals lie in the shade except for occasional movements to their food. The author also reported that during the hottest parts of the day the animals avoid the sun and kept to the shade. Gazelles lie in the sun during the cool hours of the morning and in shade during the heat of the day. For most of the time, when lying in the sun they stretch out their legs and necks as if to expose the largest possible surface area to its warmth. In shade, they normally curly their legs under their body and curve their necks to the side, probably to decrease the surface area exposed to heat. Sayied, *et .al.*, (2013) studied the behavioral patterns on the neonates during the first week of age. He observed it daily between 5:00 am to 8:00 pm and he noticed the surroundings and the behavioral patterns between mothers and their off-springs at the morning. Daily activities of Dorcas gazelle *G. dorcas* observed by Mohamed (2014) in Kuku Zoological garden were; lying down 43.8%, eating 21.5%, walking 11.9%, standing 11.25%, ruminating 10%, playing 2.17%, un-restfulness 1.5% , drinking 0.27%, defecating 0.019% and urinating 0.011%.

2.6. Feeding Dorcas Gazelle

2.6.1. Natural Habitat Feeding

Habibi (1990) described the feeding of Dorcas gazelle in the wild. He said that Dorcas gazelle feed on the flowers, leaves and pods of *Acacia* trees in many areas where they inhabit, while in the Negev desert *Gazella dorcas* feeds on Madonna lilies (*Pancreatium sicken bergaeri*). According to Lawes and Nanni (1993) and Ward and Saltz (1994) the gazelle had high selectivity pattern of grassing and herbs provided these enough quality feed to supplement their needs (Abturov, *et. al.*, 1996). Yom-Tov *et. al.*, (1995), observed dorcas gazelles feed on leaves flowers and pods of various *Acacia* trees (*A. raddiana*, *A. tortilis*), young twigs and/or fruits of several species of bushes. The authors reported that the gazelle prefer *Astragalus vogelli*, *Astragalus spinosus*, *Crotalaria aegyptia*, *Eragrostris bipinnata*, *Nitraria retusa*, *Ochradenus baccatus*, and *Zizyphus spinachristi*, but also eat *Argyrolobium saharae*, *Convolvulus tanatu*, *Farsettia-ramosissima*, *Hippocrepis constricta*, and *Trichodesma africanus*. According to (Habibi, 1989) the food of Dorcas gazelles in their natural habitat depends on plants of autumn season while in the dry seasons, their diet consists mainly of shrubs and grasses on the edge of creeks and valleys which provided them with food and water. In the dry season their food items include *Acacia* spp., *Maerua-crassifolia*, *Nitraria retusa*, *Citrullus colocynthis (vulgaris)*, *Chrozophora-brocchiana*, *Leptadenia pyrotechnica*, *Zizyphus* spp, *Balanites aegyptiaca* (Carlisle and Ghobrial, 1968; Newby, 1974; Obsorn and Helmy, 1980; Grettenberger, 1987). During the wet season, perennial grasses and forbs such as *Panicum turgidum*, *Tribulus* spp. and *Stipagrotis* spp. are heavily utilized (Grettenberger, 1987). According to Lawes and Nanni (1993) and Ward and Saltz (1994) the Dorcas gazelle feed on leaves, twigs and fruits of variety of bushes. Furthermore, Freeland and Jansen (1974) reviewed that herbivores avoid exceeding toxic

threshold of secondary plant metabolites by feeding on variety of plant species. Henely and Ward (2006) reported that the dorcas gazelle in the Negev desert, in Palestine, select their diets at the level of plant parts not species. The major factors influencing food selection in herbivores is mainly the energy, water and toxic contents of consumed plants (Lagarde, *et. al.*, 2003). Henley and Ward, (2006) suggested that, Dorcas gazelles in Morocco, may even consume toxic plants which could be rich in some potentially required materials. Herbivores avoid exceeding toxic threshold of secondary plants metabolites by feeding on a variety of plant species (Freeland and Jansen, 1974). However, Dorcas gazelles can feed on the *Medona lil* (Amaylidaese) grow in Negev desert (Ward and Saltz, 1994), which is very toxic due to high content of calcium oxalate; but the gazelles seem to eat only these parts of leaves where calcium oxalate are absent. Jungius (1971) studied the gazelle and concluded that its main diet was grass, including a total of 15 species. Only during the dry season, this species browse shrubs and trees as well.

2.6.2. Dietary Requirements of Captive Dorcas gazelle

Smith, *et. al.* (1997) reported that a diet of good quality grass and alfalfa hays, supplemented with commercial diets, will provide adequate nutrition for most gazelle species. In addition to hay, all gazelles receive an allowance of feeding pellets (Crandall, 1964). Crandall (1964) described the general diet used for dorcas gazelles as consists of alfalfa and the feeding pellets sometimes mixed with oats and cut vegetables. According to the feeding regime used by Sayied (1999), adult gazelles were fed in captivity diets consisting of fresh alfalfa, alfalfa-hay and sorghum grains and Minerals salt blocks and drinking water were available *ad lib*. Mohamed (2014) stated that adult gazelles in captivity were fed in a diets consisting of fresh alfalfa, alfalfa-hay, sorghum grains and Mixture of sorghum and wheat bran and minerals salt blocks and drinking water were available *ad lib*.

2.6.2.1. Protein Requirement

Amino acids are essential for body function; however, very few wildlife studies have examined amino acid composition or requirements (Scott, 1968). Dietary protein requirements for early growth in weanling gazelle range from 13-20% (Smith, *et. al.*, 1975). The dietary protein requirements for maintenance of adult gazelle range from 5.5-9% (Holter, *et. al.*, 1979).

2.6.2.2. Protein Level

According to study conducted by Hoppe (1977), crude protein and crude fibre for Dorcas gazelle in captivity were 69, 77 and 52% respectively. During lactation, the dry matter intake increased by 50%.

2.6.2.3. Other Requirements

2.6.2.3.1. Water

Cloudsley-Thompson and Ghobrial (1965) discussed the physiological basis for the capacity of Dorcas gazelles to survive in extreme desert areas, under restricted water intake and fluctuated temperature. A total of 1083 g of Acacia leaves provided all the necessary energy, and more than its minimum requirement of water in November (Carlisle and Ghobrial, 1968). The average daily water consumption of these gazelles (from drinking, metabolic water and water in food) was 590 ml during November and 840 ml during May. Captive dorcas gazelles drink water equivalent to 3.1 % (1.0-4.9 %) of their body mass daily (Ghobrial, 1974 and 1976).

2.6.2.3.2. Minerals

According to Abaigar (1993) normal Calcium and Phosphorus values in healthy gazelles, have been reported as 6.1-15.2 mg/dl and 2.7-8.35 mg/dl, respectively

2.7. The Socio-economic Importance of Dorcas Gazelle

Habibi and Boef, (1997) said that Dorcas gazelle thrived in the Arabian Peninsula for thousands of years and in many countries and considered as socio-economic importance for Bedouins and humans in rural regions as they provided them with food and proteins, also caught gazelles to keep them in camps during his travels to be sold to villages in the market . The authors discussed the great importance of this gazelle to Bedouins people rather than economics such as; gazelles played an important role in the cultural life of Arabs and fascinated people for centuries. Also the authors reported that skin of newborn gazelles are used to make a sack called (Jerab) used for storing coffee beans, and the gazelle's horn was used by women to pull thread while weaving. According to the report of SSA (2011), *Gazella dorcas* could become an important factor for the development of tourism, both for hunters and photographers, and should become an important source of food supply for the local people.

In the Sudan their market value, meat production and other valuable products are not yet studied (Sayied and Ibn Oaf, 2001). Revenues can be generated from the sale, production in closed system and high prices for fawns have been recorded (Sayied, *et. al.*, 1998).

CHAPTER III

3. MATERIALS AND METHODS

3.1. The Experimental Animals

The experiments were conducted during the period (15th February - 30th of March 2018). The animals used in these experiments were dorcas gazelle (*Gazella dorcas*). Fourteen animals (7 males and 7 females) described as ten adult between the ages (11 – 108 months) and four wearing between the ages (4 – 9 months) were used.

3.2. Housing

The house was built within the miming of Kuku Zoological Garden with solid concrete block walls up to 0.5 m. height all around. The roof was made of insular metal shed. Animals were housed in pens prepared inside the house each pen with dimensions: 6m. ×2.8m. ×3m. The pens were surrounded by metal pipe at the interval of 3 Meta heights. The ground was concrete. Water basin and plastic feeder was added to each pen. Four pairs of adult animals were lodged in four pens with male and female for each. And six animals lodged as whole in one pen.



Figure 2: Captive Dorcas gazelles

3.3. Body Measurements of Dorcas Gazelle

Morphological data were collected from 14 gazelle (7 males and 7 females). Body weight (the mass) was determined by mounting a standard foot scale to the nearest kilograms. Horn length was measured by using a soft measuring tape calibrated in millimeters per centimeter as prescribed by (Bothma ,1989, Cunningham, et.al.,2011), total length (i.e., from the point of shoulder to the pin bone), fore-limbs length (i.e., from the tarsal to the fetlock joint after flexing the knee), hind-limbs length (i.e., from the hock to the fetlock joint after flexing the hock), facial length (i.e. from the tip of the nostrils to the base of the horns in a straight line), shoulder height (i.e., from the tip of the left shoulder blade to the tip of the left hoof), ear length (i.e., from the notch of the left ear opening to the tip of the ear) and tail length was measured by using a soft measuring tape according to Mohamed, et. al., (2012) and Mohamed (2014). The age of some individuals was known (captive born) retrieved from the Kuku Zoo ARKS (Animal Record Keeping System), while other gazelle's age classes based on body size and hornes structure according to Hvidberg-Hansen and De Vos (1971), Walther (1973) and Loggers (1992).

3.4. Food Preference Experiment

The study was done on two adult pairs of Dorcas gazelle kept in an enclosure pens. The animals were captivated for twenty four months before the initiation of the experiment to allow them becomes adjusted to the breeding pens. The gazelles were introduce to the diets for a week to get adapted and to estimate the maximum amount they can consume before commence of the experiment.

The experiment was conducted over a period of fifteen days, during the experiment the animals were observed for the preferable of the following food stuff, Alfalfa (*Medicago sativa*), Sorghum (*Sorghum vulgare*), common wheat bran (*Triticum aestivum*), and Sorghum straw (*Sorghum bicolor*). Feed intake (kg/group) was

recorded on daily basis by difference between offers (10 kgs) and residues. Minerals salt blocks and drinking water were available *ad lib*.



Figure 3: Feeding of captive adult Dorcas gazelle

3.5. Behavior of Dorcas Gazelle Experiment

Two pairs of mature dorcas gazelle, 57 month old at average were used. The observation extended over the period of 15th February to 30th of March 2018. Total of seventy-two hours observation was done at different periods of the day (Oduro et al, 2002). Ten different activities performed by the animals were observed, timed and recorded, they included self-grooming and the grooming of each other, rubbing of cheeks against each other or object, licking of objects, yawning, sneezing, mounting, sniffing and coughing. The ten main activities observed were; standing, eating, pacing/walking, lying down, playing, drinking, ruminating, mating, urinating and defecating.

3.6. Statistical Analysis

The data obtained in the behavior and morphological measurements studies were subjected to independent sample T-test (Snedecor and Cochran, 1967). Descriptive procedure was adopted in representing results as frequency and percentages for food preference (Montgomery, 1984; Oduro, *et. al.*, 2002)

CHAPTER IV

4. RESULTS

4.1. Body Measurements

Table (1) shows Body weight, Morphological measurement and approximate ages of adult male and female dorcas gazelle. Mean Body weight for adult male was (11.57kg) while the mean body weight for adult female was (10.74kg) and the overall weight was $(12.52 \pm 2.66\text{kg})$. Mean total length for adult male was (89.57cm) while for adult female was (80.6cm) and the mean horns length for adult male was (29.14cm) while for adult female was (24.6cm).

Table (2) shows Body weight, Morphological measurements and approximate ages of Fawns and juvenile male and female dorcas gazelle. Mean Body weight for young male was (4.75kg) while the mean body weight for young female was (8kg) and the overall weight was $(6.38 \pm 1.93\text{kg})$. Mean total length for young male was (58cm) while for young female was (82cm) and the mean horns length for young male was (11.5cm) while for young female was (11.75cm).

Figure (4) shows the horn length vs. approximate ages for Dorcas gazelle. From the figure, the horn increase with the increase of the age. The figure (5) shows the Body weight vs. Approximate Ages for dorcas gazelle. As the age increase the body weight increase.

**Table (1): Body weight (Kg), Morphological measurements (Cm)
and approximate ages (Months) for adult gazelles**

Sex	BW	TL	FL	HL	Tail	EL	Horne	Face	Stand	Age
M	10	103	65	74	25	23	30	21	59	36
M	16	113	63	80	26	21	35	21	53	60
M	15	97	68	79	29	23	40	25	51	108
M	16.5	100	62	80	23	19	37	18	53	48
M	14	98	61	72	24	21	39	22	53	72
M-means	11.57	89.57	56.71	68.71	23.42	19.71	29.14	19.42	47.14	47.85
FM	10.5	80	53	61	21	20	16	16	46	11
FM	9	82	60	73	22	19	27	18	50	36
FM	11.5	81	58	72	19	18	15	21	50	30
FM	12	82	54	63	24	20	36	20	46	36
FM	10.7	78	51	69	21	18	29	18	42	26
FM-means	10.74	80.6	55.2	67.6	21.4	19	24.6	18.6	46.8	27.8
Overall means ±sd	12.52± 2.66	91.4± 12.22	59.5± 5.48	72.3± 6.60	23.4± 2.88	20.2± 1.81	30.4± 8.95	20± 2.58	50.3± 4.76	46.3± 27.69

M= Male; FM= Female; BW; Body Weight; TL= Total Length; FL= Fore limbs Length; HL= Hind Limb Length; Tail= Tail

Length;

EL= Ears Length; Horne= Horne's Length; Face= Face Length; Stand= High or up throw ground; Age= Approximate Ag

**Table (2): Body weight (Kg), Morphological measurements (Cm)
and approximate ages (Months) for juvenile gazelles**

Sex	BW	TL	FL	HL	Tail	EL	Horne	Face	Stand	Age
M	5	66	42	51	20	16	17	16	32	7
M	4.5	50	36	45	17	15	6	13	29	4
M-means	4.75	58	39	48	18.5	15.5	11.5	14.5	30.5	5.5
FM	7.5	68	50	62	18	18	8	14	42	7
FM	8.5	96	58	62	21	20	16	24	50	9
FM-means	8	82	54	62	19.5	19	12	19	46	8
Overall means ±sd	6.38± 1.93	70± 19.11	46.5± 9.57	55± 8.45	19± 1.83	17.25± 2.22	11.75± 5.56	16.75± 4.99	38.25± 9.60	6.75± 2.06

M= Male; FM= Female; BW; Body Weight; TL= Total Length; FL= Fore limbs Length; HL= Hind Limb Length; Tail= Tail

Length;

EL= Ears Length; Horne= Horne's Length; Face= Face Length; Stand= High or up throw ground; Age= Approximate Ages

Figure (4): Horne length vs. Approximate Ages for dorcas gazelle

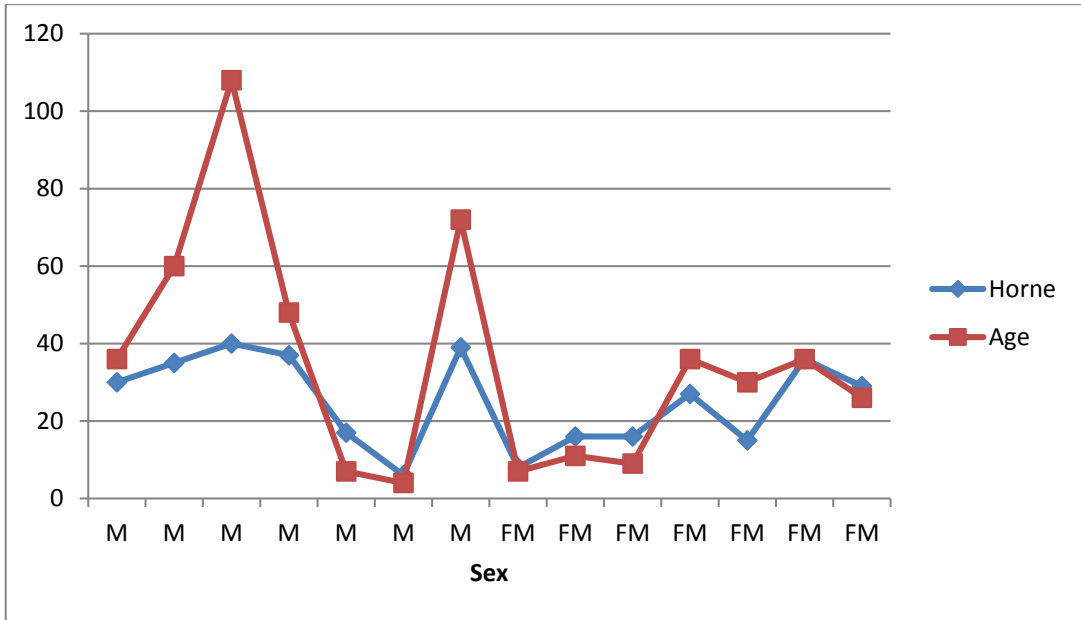
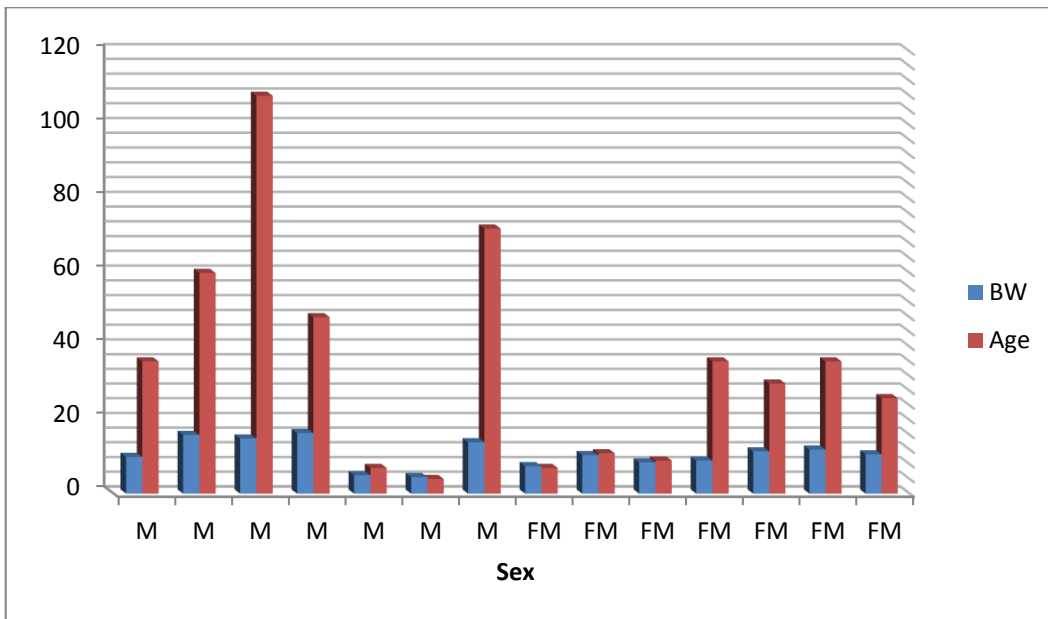


Figure (5): Body weight vs. Approximate Ages for Dorcas gazelle



4.2. Food Preferences

Table (3) shows average daily consumption (kg) of Alfalfa, Sorghum grains, Mixture (Feterita + wheat bran), and Sorghum straw consumed and the pattern of food consumption by Dorcas gazelle in captivity. There were significant differences ($P < 0.05$) between diets in the weight of food consumed. Feterita grains were the most preferred diet with intake 643 ± 219.66 g (between 355 and 905 g) per day, followed by Mixture (Feterita + wheat bran) with daily intake 434.67 ± 148.39 g (between 290 and 660g), followed by Alfalfa hay (Barseem) with intake 199.33 ± 69.01 g (between 150 and 310 g) per day the least preferred diet was that of the Abu 70 (Sorghum dry straw) with intake 141.3 ± 52.55 g (between 92.5 and 265 g) per day.

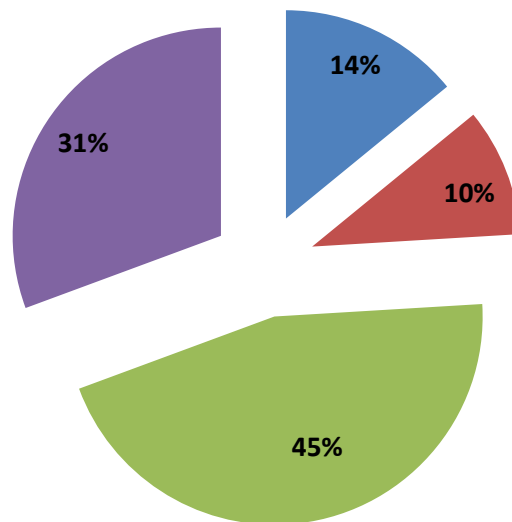
Fig (6) shows the percentage ratio of diet consumption. The percentage consumption of Sorghum grain was higher (45%) while Sorghum straw was the lower consumption percentage (10%).

Table (3): Average daily consumption (kg) of Alfalfa, Sorghum grains, Mixture (Feterita + wheat bran), and Sorghum straw by Dorcas gazelle in captivity

Days	Diets (kg)			
	Alfalfa hay or Barseem	Abu70/ Dry straw	Feterita grains	Mixture (Feterita + wheat bran)
Day 1	280	265	855	660
Day 2	285	190	845	560
Day 3	170	210	870	560
Day 4	285	160	905	350
Day 5	310	150	835	320
Day 6	195	135	800	340
Day 7	155	150	585	350
Day 8	160	130	635	290
Day 9	155	115	485	565
Day 10	190	105	615	320
Day 11	150	92.5	510	315
Day 12	202.5	110	465	415
Day 13	170	115	510	470
Day 14	125	97.5	375	455
Day 15	165	95	355	550
Mean	199.83	141.3	643	434.67
SD	69.01	52.55	219.66	148.39

Figure 6: Percentage of average daily consumption

■ Barseem ■ Abu70 ■ Feterita ■ Mixture



4.3. Behavior Patterns:

Table (4) shows the time spent and daily percent share of captive Dorcas gazelle behavioral patterns. The highest share (87.83 ± 16.66 and 85.19 ± 17.41) was for laying down for male and female respectively. Standing, eating, pacing, and ruminating activities constitute more than 50% of day time behavior. Laying down, drinking, mating, urination and defecation take jointly about 49%. Urinating time is least of the above (0.09%).

Table (4): Time (min) according to sex, Average and percentages of each activity of Dorcas gazelle in captivity

Activities	Male	Female	Average	Percentage
Standing	25.88 ± 11.02	29.04 ± 12.4	27.46 ± 11.71	15.42%
Eating	20.01 ± 7.76	17.13 ± 8.71	18.57 ± 8.23	10.42%
Pacing	20.36 ± 7.76	21.01 ± 11.18	20.68 ± 17.03	11.61%
Lying down	87.83 ± 16.66	85.19 ± 17.41	86.51 ± 17.03	48.56%
Playing	6.24 ± 4.62	5.76 ± 5.36	5.99 ± 4.97	3.36%
Drinking	0.32 ± 0.3	0.36 ± 0.32	0.34 ± 0.31	0.19%
Ruminating	17.6 ± 7.86	17.85 ± 8.19	17.72 ± 8.03	9.95%
Mating	0.39 ± 0.53	0.43 ± 0.61	0.41 ± 0.57	0.23%
Urinating	0.17 ± 0.12	0.14 ± 0.13	0.16 ± 0.12	0.09%
Defecating	0.29 ± 0.21	0.31 ± 0.24	0.30 ± 0.23	0.17%

CHAPTER VI

5. DISCUSSION

The international trend for conservation of natural resources has necessitated in wildlife the stoppage of draining different species from the wild and resort instead to captive rearing (CITES, 2006). Farming some wild species like gazelles, crocodiles and ostriches has proved high economic reward due to the increasing demand of their products. In compliance with the CITES regulations in the Sudan, proper wild farming started to grow. *Gazella dorcas* varies in coloration, depending on the location. The present study presented a descriptive information on *Gazella dorcas* including body measurements, weight and age.

In the present study the average body weight of the male and female Dorcas gazelle were 13kg and 9.96kg. This value is lower than the value 16.5 kg and 12.6 kg recorded by Yom-Tov, *et.al.*(1995), Husam (2003), AMDB (2004), and Ahmed , *et. al.*, (2012). The average size varies among populations. Average Forelimb lengths measures, were found 56.7 cm and this result matches the value (50–58 cm) that reported by Mohamed (2014), and (55 cm) that reported by Ahmed, *et. al.*, (2012).

Average Forelimb lengths measures, were found 56.7 cm and this result matches the value (50–58 cm) that reported by Mohamed (2014), and the value (55 cm) that reported by Ahmed, *et. al.*, (2012) and SPE, (2016) reported that the shoulder height as (55 – 65) cm.

In the present study, horn lengths for adult male *Gazella dorcas* were found (17–40 cm) and female (18–20 cm), these measurements agree with those recorded by Mohamed (2014) who found horn lengths for adult female *Gazella dorcas* as (14–20 cm). Horns of males are 250-280 mm long and have 20-24 rings. Female's horns are smaller (170-190 mm) and straighter with 16-

18 rings (Yom-Tov, *et.al.*, 1995). Addition to that SPE, (2016) recorded the horns may have up to 25 annular rings and are lyre-shaped (point outward then came in at the tips) that means the horn of mature gazelle could be measured by total numbers of rings or by the total length (in cm). Horns of Juveniles female are slim and hooked slightly inward, whereas horns of juvenile males are prominently ringed at the base and the tips hooked sharply inward. By 18 months the horns of both sexes are about the same length as the ears. Males were classified as juveniles until their horns reached the adult stage at an estimated 30 – 36 months. Horns of adult dorcas female are longer than an ear length and lack prominent rings, those of adult males are ringed and lysate (Logger, 1992).

The most preferred diet in the present study is Feterita grains $643\pm 219.66\text{g}$, followed by Mixture (Feterita + wheat bran) $434.67\pm 148.39\text{g}$ and Alfalfa hay (Barseem) $199.33\pm 69.01\text{g}$ and the least preferred diet was Abu 70, $141.3\pm 52.55\text{g}$. This agree with the result of the study of Mohamed (2014) for dorcas gazelle which prefers Sorghum $641\text{ g}/(12\text{ hr.})$ more than other diet in captivity then followed by mixture(wheat bran+ sorghum) 419 g/day , then alfalfa hay $191\text{ g}/(12\text{ hr.})$ and the least was Abu 70 (Sorghum dry straw) $176\text{ g}/(12\text{ hr.})$. Gazella dorcas would require food of a relatively high nutritional quality to satisfy its need which would affect the food items selected (Ward and Saltz, 1994). Depending on the season, methods for obtaining food change. Large quantity of feed is observed in small areas with high concentrations of plants compared to the other feeding areas (Lawes and Nanni; 1993) and some studies reported decrease in the nutritional quality of plants under an atmosphere enriched in CO_2 . (Lawes and Nanni, 1993; Ward and Saltz, 1994; Yom-Tov,*et.al.*,1995).The decline in the nutritional requirement, especially in leaves, can reach 10-30% of the nitrogen causing an

increase in the carbon-nitrogen ratio and consequently less nourishing leaves for herbivores (Fajer, *et. al.*, 1989 and Wong,1979).In the present study the daily consumption of Dorcas gazelle is agree with Ghobrial (1967) who reported the daily consumption of dorcas gazelle of sorghum as 420 g/day during November and 380 g/day in May under captive conditions.It is suggested that this differential intake of the food may be due to differences in their nutrient content as well as taste mouth-feel and appeal as required by the animals. The authors found this difference is likely being due to selection of plants parts that are higher in protein contents than the mean quality of sum of plant parts collected. This suggests that Dorcas gazelles may diversify their diet composition in order to by-pass a diet becoming not compatible with its nutritional needs.

Activity patterns are determined by the severity of the climate. In hot summers these gazelles are mostly active at dawn and dusk. In milder temperatures they can be active all day (Ward and Saltz, 1994; Yom-Tov, *et.al.*, 1995).

The result of the present study shows that dorcas gazelle (*Gazella dorcas*) in captivity spent more time 86.51 ± 17.03 mins (48.56%) lying down as compared to a cumulative percentage of 51% contributed by ten activities. This value is agreed with Mohamed (2014) who reported lying down was the most time consuming activity 108.5 ± 47.59 min. by Dorcas gazelle in captivity. The Dorcas gazelle when conditioned to captive environment are very calm animals, spending a significant part of their time lying down with occasional eating. In the other part this value disagrees with that reported by Oduro, *et.al.* (2002) on Maxwells duiker. The variation could be attributed to species and area conditions because dorcas gazelle is a species of dry climate whereas the duiker lives in wet climate. The next higher activities were

standing and walking. It can be said that walking results in energy expenditure and expenditure of metabolic energy which necessitates eating more food to compensate for the energy loss and this is in agreement with Mohamed (2014). In the present study Pacing was the most dominant activity at early mornings and evening .The period of the day has a significant effect on the types of activities performed by an animal (Abayomi, 1991).

With constant increasing demand for export, it is clear that, the inclusion of gazelles into production system has many advantages and may provide an answer to some of the desperate problems facing wild animal production in farms. *Gazella dorcas* is hunted as a food source (Yom-Tov, *et.al.*, 1995).

CONCLUSION AND RECOMMENDATIONS

Conclusion:

The dorcas gazelles had higher preference for sorghum followed by mixture (sorghum wheat bran), Alfalfa hay and Sorghum dry straw. The Sorghum and mixture are more palatable than Alfalfa hay and Sorghum dry straw; hence it is the higher intake. The mean feed intake of more preferred diet by a pair of dorcas gazelle (two males) in captivity is about 643(g). Feterita seeds were considered as main source of energy and should be given for gazelles with suitable amount to avoid dietetic diarrhea and indigestion problems.

About behavior we conclude significant variation existed in the activity patterns of dorcas gazelle (*Gazella dorcas*) in captivity. Activity was influenced by period of day for some activities such as lying down. The animals were more active during the day; eating and walking more in the morning and evening, and lying down throughout the night.

Study of the morphological characteristic, food preference and daily activities of Dorcas gazelles in captivity helps in formulation of management programs to maintain this species, and therefore, encourage the investment projects built-up in this aspect.

Recommendations:

- There is an urgent need to conduct more studies on captive antelopes in general, with emphasis on this *gazella dorcas*, due to the scarce information available in this field.
- This study recommended conservation of this species which become an endangered species. *Gazella dorcas* could be managed in their population establishment of public Zoo gardens, producing farms and using suitable feeding regime.

- Dietary information is necessary to understand the ecology and management of Dorcas gazelle.

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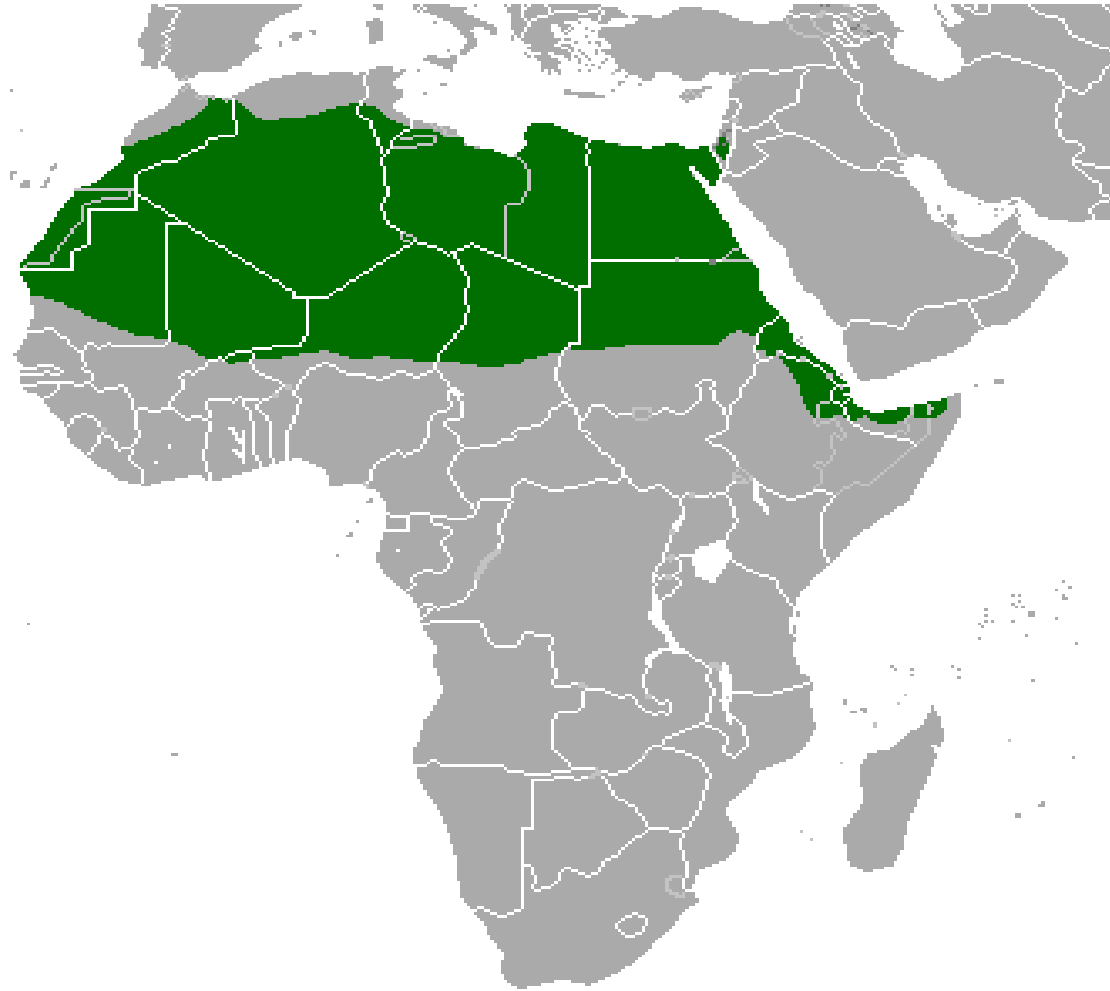
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APPENDIXES

Appendix 1: Range of *Gazella dorcas*, in the Africa Source



Source: (Encyclopedia, 2018)

Appendix 2: The wild animals kept in Kuku Zoological garden

No	English Name	Scientific Name	Arabic Name
Mammals			
1	Lions	<i>Panthera leo</i>	الأسد
2	Striped hyaena	<i>Hyaena hyaena</i>	الضبع المخطط
3	Black backed Jackal	<i>Canis mesomelas</i>	الثعلب
4	Genets	<i>Viverra genetta</i>	قط الجانيت
5	White tailed Mongoose	<i>Mungos spp</i>	النمس أبيض الذيل
6	Baboons	<i>Papio Anubis</i>	قرود البابون
7	Patas Monkeys	<i>Erythrocebus patas</i>	النسناس الأحمر
8	Grivet Monkeys	<i>Chlorocebus aethiops</i>	النسناس الأخضر
9	Dorcas gazelle	<i>Gazella dorcas</i>	غزال العادة
10	Red-fronted gazelle	<i>Eudorcas rufifrons</i>	غزال أم سير
11	Grey duiker	<i>Sylvicapra grimmia</i>	أم دقدق
12	Nubian ibex	<i>Capra nubiana</i>	العيو
13	Porcupines	<i>Hystrix galeata</i>	أب شوك
14	Rabbits	<i>Oryctolagus spp</i>	الأرانب
Reptiles			
1	Turtles	<i>Centrochelys sulcata</i>	السلحفا البرية
2	Nile Crocodiles	<i>Corcodilus niloticus</i>	التمساح النيلي
3	Pythons	<i>Python sebae</i>	الأصلة
Birds			
1	Red Necked Ostrich	<i>Struthio camelus</i>	النعام أحمر الرقبة
2	Peacock	<i>Pavo cristatus</i>	الطاووس
3	Marabou stork	<i>Leptoptils crumeniferus</i>	أبو السعن
4	Toulouse geese	<i>Anser anser</i>	الوز
5	Muscovy ducks	<i>Cairina moschata</i>	البط المسكوفي
6	Tufted Guinea fowl	<i>Numida meleagris</i>	دجاج الوادي
7	Domicile crane	<i>Grus virgo</i>	الرهو
8	Crowned crane	<i>Balearica povonina</i>	الغرنوق
9	Chestnut-bellied Sand grouse	<i>Pterocles exustus</i>	القطا
10	Bateleur	<i>Terathopius ecaudatus</i>	العقاب الحكيم
11	Turkeys	<i>Meleagris gallopavo</i>	الدجاج الرومي

Appendix 3: Time spent (mints) on various activities by D. gazelle according to period of day and sex in captive condition.

Sex	Period of day	Activities (Mints)									
		St	Et	Pa	Ld	Pl	Dri	Rum	R&M	Uri	Def
M	P1	27.02±10.54	38.15±10.50	39.74±10.88	45.10±23.26	11.95±7.23	0.51±0.71	16.40±8.83	0.56±0.41	0.16±0.05	0.48±0.13
	P2	25.68±7.64	16.66±3.69	16.38±9.02	97.14±10.96	2.40±2.44	0.26±0.26	20.12±5.10	1.79±2.81	0.05±0.06	0.14±0.11
	P3	27.41±12.24	27.36±5.87	14.02±7.91	88.81±12.84	6.86±6.34	0.82±0.59	13.95±9.10	0.18±0.12	0.29±0.19	0.49±0.28
	P4	28.57±14.48	32.40±17.50	36.19±14.19	52.64±22.48	11.52±7.95	0.68±0.46	15.34±8.10	0.08±0.10	0.39±0.23	0.22±0.23
	P5	25.85±9.04	19.35±8.21	25.43±6.73	82.74±24.07	12.50±7.43	0.18±0.20	17.43±2.45	0.31±0.37	0.20±0.23	0.10±0.15
	P6	20.90±9.53	2.91±4.54	5.63±3.34	111.55±9.61	3.12±3.76	0.08±0.15	25.48±16.14	0.01±0.01	0.04±0.06	0.09±0.09
	P7	15.25±10.23	4.73±5.31	1.93±2.89	137.18±16.44	0.0±0.0	0.0±0.0	13.59±10.69	0.0±0.0a	0.02±0.03	0.19±0.26
	P8	36.38±14.45	18.51±6.47	23.52±7.10	87.46±13.64	1.54±1.83	0.01±0.03	18.47±2.50	0.21±0.38	0.20±0.10	0.59±0.42
	Mean±SD	25.88±11.02	20.01±7.76	20.36±7.76	87.83±16.66	6.24±4.62	0.32±0.3	17.6±7.86	0.39±0.53	0.17±0.12	0.29±0.21
FM	P1	27.74±10.98	32.49±17.30	37.34±14.52	48.45±26.65	12.88±6.90	0.17±0.28	22.90±3.83	0.52±0.53	0.18±0.06	0.49±0.30
	P2	23.39±11.04	21.5±5.20	20.03±10.51	99.90±17.89	3.68±6.15	0.65±0.59	24.12±8.11	1.63±2.61	0.17±0.16	0.46±0.27
	P3	22.97±5.73	18.97±5.13	23.40±19.85	71.62±25.39	7.29±7.95	0.58±0.59	15.56±9.80	0.38±0.57	0.11±0.10	0.36±0.37
	P4	27.17±10.33	21.82±15.02	36.45±13.03	66.47±9.05	10.3±9.09	1.05±0.52	12.40±6.37	0.16±0.22	0.17±0.18	0.26±0.22
	P5	38.55±20.05	19.33±17.71	20.88±13.49	70.55±22.66	5.13±6.89	0.12±0.10	14.69±8.96	0.48±0.61	0.30±0.26	0.17±0.22
	P6	28.1±7.49	4.58±4.06	3.84±4.92	113.22±9.98	0.0±0.0	0.29±0.39	16.67±8.22	0.0±0.0	0.02±0.03	0.03±0.08
	P7	28.42±21.04	0.06±0.09	3.37±3.52	122.5±12.46	0.25±0.61	0.03±0.06	13.46±14.21	0.0±0.0a	0.06±0.10	0.20±0.26
	P8	36±12.55	18.27±5.13	22.79±9.59	88.77±15.16	6.52±5.25	0.0±0.0	22.99±6.03	0.26±0.37	0.13±0.14	0.54±0.23
Mean±SD	29.04±12.40	17.13±8.71	21.01±11.18	85.19±17.41	5.76±5.36	0.36±0.32	17.85±8.19	0.43±0.61	0.14±0.13	0.31±0.24	
Grand mean (Period)	27.46±11.71	18.57±8.23	20.68±9.47	86.51±17.03	5.99±4.97	0.34±0.31	17.72±8.03	0.41±0.57	0.16±0.12	0.3±0.23	

St; Standing; **Et;** Eating; **Pa;** Pacing/Walking; **Ld.;** Lying down; **Pl;** Playing; **Dri.;** Drinking; **Rum;** Ruminating; **R&M;** Romancing & Mating; **Uri;** Urinating; **Def.;** Defecating

