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# Effect of Tied and Free Housing Systems on Behavioural Activities and Welfare of Egyptian Buffalo Heifers

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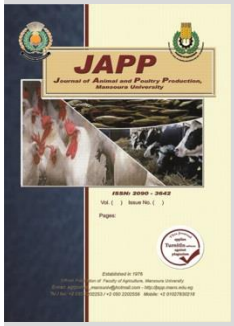


## ABSTRACT

This study was conducted at Research Unit for Animal Behaviour, Menoufia University, Egypt to evaluate the effect of tied or free system on eating and rumination behaviours, stress signs, fecal characteristics, and blood parameters, which could be reflect animal's welfare. Eight Egyptian buffalo heifers were kept in tie-stall barn for four weeks then released from restraints for another four weeks after that tied them for another four weeks up to the end of experiment. Results indicated that, eating time (306.13 min/day) and rumination time (317.93 min/day) were longer in tied heifers than in free animals (178.66 and 306.40 min/day, respectively). The tied animals were acting more stressful than those free; where stepping, kicking and tail movements were more frequently in tied (27.73, 0.80and 115.93 time/day) than in free (16.13, 0.00 and 60.00 time/day respectively). Heifers did not show any aggression (av. Test score 1, 2) in both systems. The position of the ear was backward and down during eating, ruminating, and sleeping, being more obvious in tied animals than in free animals. Total leukocyte count was higher ($P<0.05$) in free animals (15.26 $\times 10^3$/uL) than in tied stalls (11.41 $\times 10^3$/uL). The percentage of undigested components of fecal yield was higher ($P<0.05$) in free than in tied animals. It could be concluded that the free heifers were more comfortable and in better emotional status. The level of free animals' immunity and their readiness to adapt and face dangers were higher. The tied animals might have a better digestion status.

***Keywords*:** behaviour, buffalo heifers, welfare, fecal characteristics

## INTRODUCTION

In Egypt, about 96% of the total number of livestock and buffalo belongs to smallholders; they tie animals as 1-5 head in small pens (Abou-Bakr, 2008).

Housing conditions strongly influenced the behaviour and endocrine activity of the calves; the tethered calves showed greater activity scores and shorter intervals of immobility than free calves Dantzer *et al.* (1983). Also, many studies reported reduced levels of comfort (Ostojić-Andrić *et al.*, 2011 ; Popescu *et al.*, 2014), elevated physiological stress markers (Tarantola *et al.*, 2016), and a more negative emotional state (Popescu *et al.*, 2014) for cows kept in tie stalls. Tethering is an ineffective method for upholding a minimally acceptable welfare standard. (Le Neinder 1993). On the other side, tied cattle are not entirely disadvantaged by the lack of social contact , which can reduce the risk of agonistic interactions (Popescu *et al.*, 2014 and Proud foot and Habing, 2015); in addition, By reducing the amount of time spent on other activities like sleeping, strolling, fighting, and socializing, tethering encourages cattle to concentrate more on eating. (Rachmat *et al.*, 1992).

Although comparing free and tied housing systems is not new, many important measurements have emerged recently to evaluate animal welfare, such as animals' behaviour (daily activities and stress behaviour), avoidance tests, ear postures, some blood parameters, and fecal characteristics, which may give more accurate results.

Behavioural responses are the most pertinent indicators of the well-being of an animal (Le neindre *et al.*, 2004; Moura *et al.*, 2006). If an animal exhibits any signs of strain or is suited to the production system, it can be determined by behaviour tests and measurements (Singh *et al.*, 1993). The animal-human relationship, is a crucial component of on-farm welfare evaluation programs (Rousing and Waiblinger 2004; Waiblinger *et al.*, 2004 and Winckler *et al.*, 2003); which can be evaluated through avoidance or, approach tests (Hemsworth and Coleman, 1998 and Rousing and Waiblinger 2004).

The cow's ear postures can reveal information about its emotional condition both instantly and over an extended period of time. (Proctor and Carder 2014). Fecal examination is one of several important sources of information that are gathered from all sections of the farm in order to examine general herd health and nutrition. Fecal evaluation, when combined with a detailed analysis of food and management techniques, can assist clarify issues related to animal health and whole animal nutrient use (Kononoff *et al.*, 2015).

Therefore, the aim of this study was to determine the negative and positive effects of the tied housing system (the most widespread in Egypt) on Egyptian buffalo heifers' behaviour (daily activities and stress behaviour), avoidance tests, ear postures, some blood parameters, and fecal characteristics.

## MATERIALS AND METHODS

This study was carried out at the research unit for animal behaviour, belonging to the faculty of agriculture at Menoufia University, Shebin El-kom, Egypt. All experimental procedures were approved by the scientific

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research ethics and animal use committee (SRE & AUC) – Faculty of Agriculture – Menoufia University, Egypt. Approval №: ٥١٦ – SRE & AUC-MUAGR - ٥٦-٢٠٢٤

**Animals and Management:**

Eight Egyptian buffalo heifers, representing part of the behaviour unit research herd, aged about 12-14 months and averaged 287 ± 22 kg of body weight (BW); were randomly chosen for this study. The heifers were kept in closed housing system in tie-stall barn with a hard surface for four weeks, and then released from restraints in the same pen (12 x 12.5 $m^2$) for another four weeks. After that they were tied for another four weeks up to the end of the experiment. Animals were fed Egyptian clover (*Trifolium alexandrinum*), rice straw and concentrate mixture. The Concentrate mixture was restrictedly offered twice daily (10 a.m. and 7 p.m.) according to their requirements; on the other hand, the roughage was presented ad-lib at the feed manger. Water was available ad-lib from automatic drinkers. The lighting was adequate for monitoring the animals during the day, while industrial dim lighting was used at night.

**Studied Criteria:**

**Animal behaviour:**

The experiment lasted for twelve weeks from January to April 2020. During this period, studied animals under each housing system were video recorded for 72 h. utilizing a full digital behavioural observation unit, which consists of eight digital observation cameras, a digital storage unit, and a control unit. Each animal was observed for a total of 216 hours (72 h. × 3). Throughout the observation periods, each animal's activity and stress behaviour patterns were recorded using continuous observation techniques.

**Animal activities**

A. Frequency and duration of eating behaviour: mouth, chewing, or putting the head down in the manger near the food (Alzahal *et al*. 2006).
B. The frequency and duration of rumination behaviour is the period of time the animals were chewing the bolus again rather than eating (mezzalira *et al.*, 2012).
C. Frequency and total period of lying behaviour: A lie was described as having all four legs relaxed with the undersides touching the ground (Weimer 2012).
D. Frequency of drinking, defecating and urinating behaviours (time/day).

**Stress behaviour:**

The behavioural criteria observed were the frequency of kicking, stepping (leg movement) and tail movements. The differentiation between kicking and stepping was as follows: Stepping, or leg movement, was noted whenever one hoof was raised less than 15 cm off the ground, and kicking was defined as a kick in any direction that raised the hoof at least 15 cm off the ground according to De Rosa *et al.* (2003). A tail movement was recorded whenever the tail swing beyond the side of the animal as mentioned by Munksgaard *et al. (2001)*. The results were expressed as the frequency per day (time/day) and frequency rate per unit of time (time/hour). Animals under each housing system were video recorded for three consecutive days.

**Avoidance (AV) test:**

Avoidance (AV) test was conducted individually for the two housing systems (tied and free) for all experimental animals three times a day (10 h., 12 h. and 14 h.) as described by Rousing and Waiblinger (2004) as follows: The tester person approached each animal in a standard manner, which included approaching the animal from about the front, moving slowly (about one step per second), glancing at the heifer without peering into its eyes, and keeping hands and arms near to the body. The tester person approached each individual animal after waiting for her to give him a look. At a distance of approximately 1m from the animal, the tester person stopped and slowly stretches out one hand. After approximately 10 s, the tester person attempted to touch the neck of the tested animal. The test was ended whenever the animal withdrew—defined as taking steps away from the person. The animal's behaviour was classified based on when it withdrew in relation to the person's distance as follows. Category 1: The animal stayed more than two meters away from the approaching tester person. Category 2: The animal retreated 1.5–2 meters away from the advancing person. Category 3: The animal stopped at a distance of 1 m and withdrew from the person at a distance of less than 1.5 m, but avoided the tester person when he extended his hand. Category 4: The animal did not object to the tester subject reaching out his hand, but it did not want to be touched. Category 5: The touch was accepted by the animal.

**Ear Postures:**

By monitoring and recording the position of the ear pinna over a day (24-h.). Proctor and Carder (2014) assumed that there are four ear positions; the focal cow's head and neck were positioned above the ear, and the ear pinna was either facing forward or sideways in the first ear posture. In the second ear position, the ear was held horizontally and the ear pinna was facing front in front of the cow. The third ear posture involved holding the ear backwards on the cow's head without it being erect or passively drooping. In the fourth ear posture, the ear pinna was facing downward and the ear was hanging loosely, naturally falling perpendicular to the head.

The ear pinna of the Egyptian buffalo is large and heavy, so the animal is not able to direct it upwards, unlike horses and donkeys; therefore, only three ear positions were recorded: forward, backward and down (Fig.1). Each of the full video focal observations were analyzed to determine the number of ear posture changes, frequency, and the time spent, period, in each of the three ear postures over a day (24 h.).

**Forward position**

**Backward position**

**Down position**

**Figure 1. Ear Postures of Egyptian buffaloes heifers:**

**Fecal characteristics:**

**Fecal Score:**

The manure produced by each heifer was evaluated individually over a 24 hour period for three consecutive days under each housing systems. Fecal consistency (FC) was evaluated using the 5 points scale with a score of 1 being very fluid and 5 being extremely dry and segmented and 3 were the ideal consistency for manure as proposed by Skidmore *et al.* (1996), as shown in Table 1.

**Table 1. Fecal condition scoring chart for buffalo heifers**:

| Score | Consistency | Picture |
|---|---|---|
| Score 1 | This manure is very liquid with the consistency of pea soup. The manure may actually "arc" from the heifer |  |
| Score 2 | This excrement doesn't seem to be in a solid pile and looks sloppy. It will splatter when it hits concrete or the ground, and its height will be less than an inch. |  |
| Score 3 | The manure has a porridge-like appearance, will stack up 1.5 to 2 inches, have several concentric rings, a small depression or dimple in the middle, make a plopping sound with it hits concrete floors, and it will stick to the toe. |  |
| Score 4 | The manure is thicker and stacks up over 2 inches. |  |
| Score 5 | This manure appears as firm fecal balls |  |

**Manure particle size**

Manure particle size was also evaluated by Cleaning manure samples. A manure sample (~1 cup) was transferred to a screen (7 inches diameter x 4 inches deep, 1/16th inch to 1 mm openings). With a gentle force of water, the sample was rinsed until the water runs clear. The particles hidden in the manure could be seen. The finest particles had washed away, but the large particles were the main concern.

**Hematological examination:**

At the end of each housing system, blood samples were collected individually from all animals' jugular vein into evacuated collection tubes containing EDTA and used for hematological examination. Samples were sent directly after collection in ice tank to the research laboratory of Faculty of Veterinary Medicine in Sadat City, Sadat City University, Egypt. Separations of plasma were performed by blood centrifugation for 15 minutes at 3000 rpm. Hematological parameters were performed directly, within two hours from collection, by using Medonic Veterinary Hematology analyzer (Medonic CA 620, Sweeden). The blood profile analysis was Complete blood count (CBC), differential leukocyte count and blood indices. The measured blood parameters included clinical biochemistry and cortisol hormone concentrations. The clinical biochemistry analysis was total protein, albumin and glucose concentrations.

**Statistical analysis:**

Experimental data were analyzed by T-test using IBM SPSS Statistics 22 statistical package (SPSS Inc., Chicago, IL, US). The experimental animal was used as an experimental unit for analyzing the experimental data. Results are expressed as means ± SEM. according to the following model:

$$Yjk = \mu + Tj + ej_k$$

**Where: $Y_{jk}$= Criteria studied for buffaloes in the jk subclass; μ = Overall mean; Tj = the effect due to the $j_{th}$ treatment, j = 1, 2 (1=free animals and 2= tied animals); ejk = Random error.**

## RESULTS AND DISCUSSION

Table 2 shows daily activities of Egyptian buffalo heifers under two housing systems (tied and free stalls). The animals spent 815.53 minutes (56.60 %) and 799.4 min. (55.51 %) of the day lying down at daily frequencies of 8.80 and 9.46 times in both tied and free systems, respectively; these differences were not significant (P>0.05). This is not consistent with Beaver et al (2021), who noted that the expression of natural behaviour, particularly lying behaviour, is inhibited in tie stalls. However, the daily eating period was significantly (P<0.01) longer in the tied system (306.13 min, 19.87%), than in free system (178.66 min, 12.40%). Although the daily rumination period was longer in the tied group (317.93 min, 24.85%), than in the free group (306.40 min, 21.27%), these differences did not reach the level of significance (P≥0.05).

Increasing the period of eating and rumination in tied system caused a dramatic increase in drinking, defecating and urinating behaviour in free system (6.80, 6.40 and 3.73 time/day respectively) vs. (5.33, 4.26 and 2.13 time/day respectively) in free system. These differences were non-significant for drinking, highly significant for defecating, and significant for urinating behaviour.

**Table 2. Daily activities of Egyptian buffalo heifers under two housing systems (tied and free).**

| Daily activity | Housing system | | Significance |
|---|---|---|---|
| | Tied heifers Mean ±SE | Free heifers Mean ±SE | |
| | Lying | | |
| Frequency (time/day) | 8.80±0.97 | 9.46±0.85 | NS |
| Time (minuet/day) | 815.53±34.39 | 799.40±29.07 | NS |
| % of the day | 56.60 | 55.51 | - |
| | Eating | | |
| Frequency (time/day) | 15.93±1.21 | 17.13±1.99 | NS |
| Time (minuet/day) | 306.13±10.72 | 178.66±23.47 | ** |
| % of the day | 19.87 | 12.40 | - |
| | Rumination | | |
| Frequency (time/day) | 14.20±0.97 | 15.46±1.50 | NS |
| Time (minuet/day) | 317.93±11.77 | 306.40±39.27 | NS |
| % of the day | 24.85 | 21.27 | - |
| Drinking (time/day) | 6.80±1.22 | 5.33±0.65 | NS |
| Defecating (time/day) | 6.40±0.44 | 4.26±0.44 | ** |
| Urinating (time/day) | 3.73±0.72 | 2.13±0.42 | * |

**NS: Not significant. * Significant at P<0.05. ** Significant at P<0.01**

It is obviously noticed that the tied animals ate and ruminated more than free animals. This may be due to the fact that, they are not occupied with any other behaviour, while free animals distracted by playing and social behaviour. This result agreed with Rachmat *et al.* (1992), who reported that

tethering reduces the amount of time that grazing cattle spend on resting, walking, fighting, and interacting with others, allowing them to concentrate more on eating.

Table 3 shows stress behaviors of Egyptian buffalo heifers under two housing systems. It is clearly appear that the animals under tied system were more stressful than those under free system, where tail movements, kicking, ans stepping frequencies were significantly higher in tied system than in free heifers. In this respect, Jensen (2001) revealed that rebound in locomotion is decreased when calves are given daily access to exercise. However, Beaver et al. (2021) mentioned that there is ample evidence that the expression of highly motivated behavioral patterns is impaired in tie stalls.

**Table 3. Stress behaviours of Egyptian buffalo heifers under two housing systems.**

| Stress behaviours | Housing system | | Significance |
|---|---|---|---|
| | Tied heifers Mean ±SE | Free heifers Mean ±SE | |
| | Tail movements | | |
| Frequency (time/day) | 115.93±36.04 | 60.00±8.63 | * |
| Rate (time/h.) | 4.83 | 2.50 | |
| | Kicking behaviour | | |
| Frequency (time/day) | 0.80±0.36 | 0.00±0.00 | * |
| Rate (time/h.) | 0.03 | 0.00 | |
| | Stepping behaviour | | |
| Frequency (time/day) | 27.73±2.99 | 16.13±2.03 | ** |
| Rate (time/h.) | 1.15 | 0.01 | |

*** Significant at P<0.05. ** Significant at P<0.01**

As evidenced by the results of avoidance test (Table 4), tied and free heifers did not show any aggression (score 1 and 2). Most of tied and free heifers showed score 3 (stopping at a distance of 1 m and withdrawing at a distance of <1.5 m), being higher for free than tied heifers. However, 24 and 29% of tethered heifers scored 4 and 5 versus 20 and 27 % of tested free animals, respectively. These results are in agreement with both Popescu *et al.* (2014) and Mattiello *et al.* (2009), who found that cattle with tethers were simpler to approach. When an animal is unable to effectively flee from the tester in a tethered system, fear may manifest itself in many ways in the animal, even if this could be a sign of improved welfare and the human-animal link. It is clear that researches published in this area are relatively few and require additional specialized studies.

**Table 4. Avoidance (AV) tests of Egyptian buffalo heifers under two housing systems.**

| Avoidance (AV) test (score) | Housing systems | |
|---|---|---|
| | Tied heifers | Free heifers |
| 1 (Av. distance at > 2m.) | 0 % | 0 % |
| 2 (Av. distance at 1.5-2m ) | 0 % | 0 % |
| 3 (Av. distance at 1m.) | 47 % | 53 % |
| 4 (Av. distance at stretching out the tester hand.) | 24 % | 20 % |
| 5 (The animal accepted touch.) | 29 % | 27 % |

Table 5 shows ear posture of Egyptian buffalo under two housing systems, tied and free. The frequency of ear positions (backward, forward and down) was not affected by housing system. However, tied and free heifers showed most of the day backward, followed by forward position, down ears were recorded for short period. Period of backward and forward ear positions were significantly longer in tied than in free heifers, but the differences in the period of down ears were not significant.

It could be noted from the present observations that the position of ear was backward and down during eating, ruminating, and sleeping, being higher with tied animals than free animals. These findings are in harmony with that reported by Proctor and Carder (2014), who found that the time spent in backward position increased as a result of the positive stimuli and suggests that this ear posture may be reflect the low arousal, positive emotional state. On the other hand, ear posture was more forward in free system (159 min) due to more exploration in free animals than tied ones. The forward ear posture was performed less frequently during the positive experiment (Proctor and Carder, 2014; Reefmann *et al*., 2009). Furthermore, Reefmann *et al.* (2012) and Boissy *et al.* (2011) found that sheep performed passive, 'plane ear' postures, similar to down cows ear posture (Proctor and Carder, 2014). The majority of the time when this passive position was used, positive stimuli was present.

**Table 5. Ear postures of Egyptian buffalo heifers under two housing systems.**

| Ear postures | Housing system | | Significance |
|---|---|---|---|
| | Tied heifers Mean ±SE | Free heifers Mean ±SE | |
| | Backward | | |
| Frequency (time/day) | 103.20±1.17 | 98.92±0.59 | NS |
| Time (minuet/day) | 1370.44±1.02 | 1259.52±4.23 | ** |
| % of the day | 95.17 | 87.47 | - |
| | Forward | | |
| Frequency (time/day) | 62.40±1.35 | 57.96±0.63 | NS |
| Time (minuet/day) | 49.92±0.98 | 159.00±4.04 | * |
| % of the day | 3.47 | 11.04 | - |
| | Down | | |
| Frequency (time/day) | 7.20±0.19 | 6.36±0.25 | NS |
| Time (minuet/day) | 19.64±0.44 | 21.48±0.97 | NS |
| % of the day | 1.36 | 1.49 | - |

**NS: Not significant. * Significant at P<0.05. ** Significant at P<0.01**

Table 6 shows hematological parameters of Egyptian buffalo heifershoused in two housing systems. It is clearly appear that hemoglobin, count of RBCs and platelets, and hematocrit percentage did not differ significantly in tied stall and free stall. However, total leukocyte count was significantly higher (P<0.05) in free than in tied animals. The higher leucocyte count (WBC) is an indicator of immune response to infections (Bradbury *et al*. (1999). Also, Soetan *et al.* (2013) mentioned that the major functions of the white blood cell and its differentials are to fight infections, defend the body by phagocytosis against invasion by foreign organisms. Thus, animals with low count of white blood cells are exposed to high risk of disease infection, while those with high counts are capable of generating antibodies in the process of phagocytosis and have high degree of resistance to diseases (Soetan *et al.,* 2013). Furthermore, these animals with high counts enhance adaptability to local environmental and disease prevalent conditions (Kabir *et al.*, 2011; Okunlola *et al.,* 2012; Iwuji and Herbert, 2012; Isaac *et al.,* 2013). Increasing total leukocyte count with free animals may be due to high physical interaction with the surrounding environment, which exposes it to a greater extent to bacteria, which increases the body's readiness for defense by increasing the number of leukocytes.

Concerning the differential leucocytes count, lymphocyte and, neutrophil percentages were not affected by housing system. MCV was significantly higher in animals at tied stall than in free stalls one (P <0.05), while MCH and MCHC were not affected by housing system.

The MCV provides the average erythrocyte cell size, MCH express the average weight of hemoglobin present in

the erythrocytes, while MCHC gives the average percentage of the MCV which the hemoglobin occupies. In goats, Al-Seaf and Al-Harbi (2012) reported that the biochemical and hematology profiles can be used to assess the immunity status (Stanger *et al*., 2005; Minka and Ayo, 2007).

**Table 6. Blood profile of Egyptian buffalo heifers housed under two housing systems**

| Blood profile | Housing system | | Significance |
|---|---|---|---|
| | Tied heifers Mean ±SE | Free heifers Mean ±SE | |
| Hemoglobin (HGB ) (g/dl) | 13.91±0.35 | 14.78±0.55 | NS |
| (hematocrit) HCT (%) | 22.80±3.62 | 21.12±0.99 | NS |
| RBCs (×$10^6$/µL) | 5.19±0.52 | 4.22±0.25 | NS |
| WBCs (×$10^3$/µL) | ١١,٤١±١,٠٢ | ١٥,٢٦±١,٠٢ | * |
| Platelet (PLT) (×103/µL) | 3443.30±708.89 | 3516.40±874.72 | NS |
| Lymphocytes (%) | 57.90±1.86 | 63.02±2.90 | NS |
| Neutrophils (%) | 33.27±2.57 | 30.16±3.26 | NS |
| MCV (fl) | 41.45±2.82 | 33.34±0.36 | * |
| MCH (pg) | 33.89±3.56 | 35.38±1.99 | NS |
| MCHC (g/ dl) | 101.45±14.11 | 106.40±7.03 | NS |

**NS: Not significant. * Significant at P<0.05.**

Table 7 shows clinical biochemical and cortisol hormone in blood plasma of Egyptian buffalo heifers that housed in two housing systems. Plasma concentration of total protein, albumin, glucose, and cortisol were not affected significantly by housing system. In contrast to our results, several reports (Redbo, 1992, 1993; Higashiyama *et al.*, 2007; Tarantola *et al.*, 2016) showed that cortisol was higher in tied than in loose-housed or exercised cattle, suggesting higher levels of stress. This variation may be associated with that cortisol levels fluctuate throughout the day (Mason and Mendl, 1993).

**Table 7. Clinical biochemistry and cortisol hormone in blood of Egyptian buffalo heifers under two housing systems.**

| Blood component | Housing system | | Significance |
|---|---|---|---|
| | Tied heifers Mean ±SE | Free heifers Mean ±SE | |
| Total protein (g/dl) | 11.21±1.31 | 12.44±0.34 | NS |
| Albumin (g/dl) | 3.98±0.12 | 3.89±0.18 | NS |
| Glucose (mg/dl) | 95.34±1.35 | 97.80±0.65 | NS |
| Cortisol hormone (µg/dl) | 1.13±0.20 | 1.36±0.29 | NS |

**NS: Not significant.**

Table 8 shows the fecal parameters of heifers in two different housing systems. Daily fecal frequencies of studied animals were more significantly (P<0.05) in tied system than in free system. Fecal yield (as fresh) was significantly (P<0.01) higher in tied animals than in free stalls and this was associated with the significant increase in eating time for the tied animals as compared to free ones (Table 2). I this context, the amount of manure produced may vary due to feed and water intake, and may be greatly reduced by an unusual disruption in passage of digestion through the digestive tract (Kononoff *et al*., 2015).

Estimated undigested fecal components (fresh or on DM basis) were significantly higher at tied stalls than that of free stalls (P<0.05), but the percentage of undigested components of fecal yield (as fresh or on DM basis) was lower in the tied system than in free system. This may indicate that free animals are not ruminating properly or that rumen passage rate is accelerated (Kononoff *et al*., 2015).

It is obviously noticed that the percentage of undigested components of fecal yield was higher with free animals than tied. This may be due to inadequate intake of fiber that is effective in stimulating rumination or maintaining normal rumen PH (Kononoff et *al*., 2015 and Mertens, 1997). The presence of large fiber particles and grain kernels in the feces indicates a too short retention of feed particles in the ruminal system to achieve a proper particle size reduction during rumination and microbial degradation (Hall, 2002).

As feeding on roughage was ad-lib, the free heifers were occupied by their social behaviors, such as playing and exploring, which led to a decrease in eaten roughage so decrease rumination period (Table 2) and thus a decrease in the digestive value, which is represented by an increase in the percentage of undigested components in manure.

**Table 8. Fecal parameters of Egyptian buffalo heifers housed in two housing systems.**

| The fecal parameters | Housing system | | Significance |
|---|---|---|---|
| | Tied heifers Mean ±SE | Free heifers Mean ±SE | |
| Fecal frequency (daily) | 7.80±0.37 | 5.60±0.67 | * |
| Daily Fecal yield (as fresh) | | | |
| Total (kg/head) | 14.46±779.34 | 9.42±784.43 | ** |
| Undigested components (g/head) | 3550.00± 227.99 | 2726.82± 198.74 | * |
| Undigested components (% of total yield) | 24.53% | 28.93% | - |
| Daily Fecal yield (dry matter based) | | | |
| Total (kg/head) | 2.80±146.45 | 2.06±165.12 | ** |
| Undigested components (g/head) | 969.70± 61.14 | 752.71± 59.22 | * |
| Undigested components (% of total yield) | 34.58% | 36.45% | - |

**NS: Not significant. * Significant at P<0.05. ** Significant at P<0.01**

The fecal score of Egyptian buffalo heifers that housed in two housing systems are shown by Table 8. Fecal score 2 and 3 were recorded as 18% and 40% respectively in the free system compared to 14 and 35% in the tied system. On the contrary, the fecal score 4 was recorded more frequently in the tied system, 53% compared to 43% in the free system. These differences may be due to the increased fiber intake, rice straw, with tied animals, as mentioned previously (table 2). In general, the significant increase in the frequency of manure scale 4 in both systems may be due to the feeding protocol on the farm, which relies on ad-lip feeding of fiber (rice straw). Robert Wells, 2013 mentioned that Score 4 manure is thick and starting to become somewhat deeper, yet is not stacking. The consistency of the manure will be equivalent to peanut butter. This manure indicates a lack of degradable rumen protein, excess low quality fiber or not enough carbohydrates in the diet.

**Table 9. Fecal score of Egyptian buffalo heifers that housed in two housing systems.**

| Fecal score | Housing system | |
|---|---|---|
| | Tied heifers | Free heifers |
| 1 (very liquid) | 0 % | 0 % |
| 2 (runny and does not form a distinct pile) | 14 % | 18 % |
| 3 (porridge-like appearance) | 33 % | 39 % |
| 4 (thicker and stacks up over 2 inches) | 53% | 43 % |
| 5 (firm fecal balls) | 0 % | 0 % |

## CONCLUSION

The Egyptian buffalo heifers under the free system were more comfortable and in better emotional status, as the rate of stress behaviours, tail movement, kicking and stepping decreased than tied animals did. The level of immunity of the free animal and its readiness to adapt and face dangers also

increased, as the number of white blood cells of free animals was higher than that of a tethered. However, the tied system seems to be better from a nutritional standpoint, as the tied heifers ate and ruminate more, leading to reducing the percentage of undigested parts in the manure.

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## تأثير أنظمة السكن المقيد والحر على الجوانب السلوكية والشعور بالراحة لعجلات الجاموس المصري

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### الملخص

أجريت هذه الدراسة بوحدة بحوث سلوك الحيوان، جامعة المنوفية، مصر لدراسة تأثير أنظمة الإسكان على سلوك الأكل والاجترار، وعلامات الإجهاد، وخصائص الروث، ومؤشرات الدم، والتي يمكن أن تعكس رفاهية الحيوان. تم تسكين ثماني عجلات جاموس مصرية في حظيرة مغلقه ومربوطه لمدة أربعة أسابيع ثم تم تحريرها من القيود لمدة أربعة أسابيع أخرى ثم ربطها أربعة أسابيع أخرى حتى نهاية التجربة. أشارت النتائج إلى أن العجلات المربوطة أكلت (٣٠٦,١٣ دقيقة/يوم) واجترت (٣١٧,٩٣ دقيقة/يوم) أكثر من الحيوانات الحرة (١٧٨,٦٦ و٣٠٦,٤٠ دقيقة/يوم على التوالي). كانت العجلات تحت النظام المقيد أكثر إجهاداً من العجلات تحت النظام الحر حيث كان معدل وقع خطواتها والرفس وهز الذيل اكثر تكرارا في النظام المقيد(٢٧,٧٣ و ٠,٨٠ و ١١٥,٩٣ مرة/يوم على التوالي) عن النظام الحر (١٦,١٣ و ٠,٠٠ و ٦٠,٠٠ مرة/يوم على التوالي). لم تظهر اى من العجلات سواء المربوطة او الحرة أى سلوك عدوانى عند الإقتراب منها على مسافة ٢ او ١,٥ متر (مقياس اختبار الاقتراب ١ و٢). كان وضع الأذن للخلف وللأسفل أثناء الأكل، والاجترار، والنوم، وهو أعلى عند الحيوانات المقيدة منه عند الحيوانات الحرة. كان إجمالي عدد كرات الدم البيضاء أعلى ($P<0.05$) للعجلات الحرة (١٥,٢٦ × ١٠$^{٣}$/ ميكرولتر) مقارنة بالمربوطة والتى كانت (١١,٤١ × ١٠$^{٣}$ / ميكرولتر). كانت نسبة المكونات غير المهضومة من محصول الروث أعلى في العجلات الحرة منها فى العجلات المربوطة. ويمكن الاستنتاج أن الأبقار في النظام الحر كانت أكثر راحة وفي حالة عاطفية أفضل، كما ارتفع مستوى مناعة الحيوان الحر واستعداده للتكيف ومواجهة الأخطار. ولكن يبدو أن الحيوانات الخاضعة للنظام المقيد أفضل من الناحية الغذائية.