

Characteristics of Algerian Dairy Cows Associated with Degradation of Wellbeing Using the Welfare Quality® Assessment Protocol

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Abstract: This study aimed to identify risk factors that have contributed to the degradation of welfare Algerian dairy cows and of each aspect of welfare, the characteristics of farms linked to their degradation in a prospect of improvement. The observations were assessed by the Welfare Quality® Assessment Protocol in 100 dairy farms for 2011 selected on their geographic location, breed, herd size, housing system, milking type and litter. Linear Model were performed using the Genstat Version 15.0 Software (VSN International Ltd., UK) which was used to evaluate the association between farms characteristics and scores of eight criterion (absence of prolonged hunger and thirst, ease of movement, comfort around resting, absence of injury and diseases, expression of other behaviour and good human-animal relationship). The scores varied widely between farms (small and large) and between systems ($p < 0.001$). Farms with hampered system (tied stalls), obtained lower scores for 'absence of prolonged thirst', 'ease of movement' and 'expression of other behaviour'; farms with Holstein cows obtained lower scores for 'absence of prolonged hunger', 'good human-animal relationship' and 'comfort around resting: particularly a long lying down times and high dirt frequency at three body areas (legs, udder and hindquarter). Also, the farms without litter and mechanically milked have obtained lower scores for 'absence of injuries' and 'absence of disease'.

Key words: Welfare, dairy cows, farm characteristics, risk factors, Holstein, scores

INTRODUCTION

Welfare is how an animal is coping with the conditions it is surrounded with. It is considered satisfactory if the following criteria are met: good health, sufficient comfort, good nutritional status, possibility of expression of natural behavior and absence of suffering (pain, fear or distress). Indeed, the intensification and modification in farming practices have significantly changed the lives of animals and made them face situations and handling that may affect their welfare such as reducing contacts between breeder and animals (Hemsworth, 2003), the increase in herd size which is accompanied by a decrease in the time available for monitoring animals. This results in a reduced ability to detect physiological phenomena (heat detection, calving) (Doherr *et al.*, 2007; Mee, 2004). Also, the restriction of space, containment, intervention routines (weighing,

vaccination, dehorning, amputation of the tail and perforation of the ears), injuries and diseases have increased reactions of stress and pain (Boissy *et al.*, 2007) and have led to the emergence of stereotyped behaviors in animals. This has led to express more concerns about animal welfare in view of societal abuses.

To assess the quality of animal welfare in breeding, it is essential to identify the situations altering their welfare. To this end, several studies have focused on the impact of farm characteristics (risk factor) on the welfare of dairy cows. These usually rest on one or two characteristics such as the link between housing, cleanliness, alterations in tegument, comfort while lying (Regula *et al.*, 2004), milk production, herd size (Rutherford *et al.*, 2008), parity (Weary and Taszkun, 2000), breed (Alban *et al.*, 1996), type of stall (Tucker *et al.*, 2009), lameness, type of bedding, season (Potterton *et al.*, 2011) and diseases (Bouzid *et al.*, 2010).

However, the few studies that have apprehended together the effect of several characteristics of farms on several aspects of welfare are those of (Gilot-Fromont and Mounier, 2014; Coignard *et al.*, 2013).

But the said studies have been carried out on farms that are based only on loose housing. While, experts have shown that the risk to welfare of farmed animals is higher in systems based on cubicle houses and tie stall, compared to systems based on pastures and straw yards.

In this context and in order to better understand risk that affect the welfare of dairy cows and open the way to action plans focusing on these risks, a study was conducted by the protocol Welfare Quality® in 100 Algerian dairy cows based on a set of characteristics.

MATERIALS AND METHODS

Characterization of the study area and sampling of farms surveyed: This study was conducted in the province of Algiers, located along the Mediterranean Sea, characterized by its rich soil offering a variety of crops (arboriculture, market gardening, wine) and domestic animals (12369 cattle including 6392 dairy cows).

From the list of dairy farmers in the province of Algiers (970 farmers), we have selected farms only according to their production type (dairy cattle), the number of dairy cows (≥ 6) and compliance with the national milk rehabilitation program.

Once the list was established, we conducted a random drawing over 200 farmers spread over 13 agricultural subdivisions of the province of Algiers divided into two areas: the Sahel region of Algiers (Cheraga, Reghaia, Birkhadem, AinTayaDrariaZeralda, El Harrach, Bordj El Kiffan and Bouzareah) and Mitidja (Birtouta, Baraki, Dar El Beida and Rouiba).

Once the study sample was developed, we contacted the farmers. Among the selected farmers, only 100 were willing to voluntarily participate in this study.

Survey: The survey was conducted on a stratified sample of 100 Algerian dairy farms for the year 2011 over a period of 6 months (15 March to 15 September 2011) with an average of 12 ± 7.9 cows/by farm with a minimum of 6 cows by farm and a maximum of 53 having an average daily milk production of 16 L. Those cows belonged to different breeds: Holstein (44.6%), Montbeliarde (34.3%), Fleckvohie (9.7%) and Brown Alpine (11.4%) with an average of 2 breeds per farm. The 53.0% of the visited farms are conducted in permanent (zero-grazing) or partial (47%) tied stall with access to outdoor loafing area (28.0%) or a pasture (19.0%) from spring to summer.

Six stratification criteria were selected to represent the diversity of dairy cows in the province of Algiers: geographic location (the area of Sahel Algiers and the Mitidja area); herd size: small (A): <10 cows, medium (B): <10 cows <20 and large farms (C): >20 cows; housing system: Free Grazing (FG): Outdoor loafing Area (OA) and Tied Stall (TS); breed: Holstein (HN), Montbeliarde (Mt), Fleckvohie (Fleck) and Brown Swiss (Br); Type of milking: Mechanical (Mec) or Manual (Man) and Litter: Presence (Pres) or Absence (Abs).

The observations were carried out by the same observer and lasted one day per farm (started just after the morning milking and ended in the afternoon) on the basis of a questionnaire inspired from. The latter included qualitative and quantitative variables informing about the status of animals (body condition score), farming practices (maintenance of drinking troughs and functioning, the degree of freedom of cows, access to pasture or exercise area), comfort (cleanliness, injuries, sleeping area), their health status (diseases) and their behavior (state of fear, agonistic or positive emotion).

Statistical analysis: We used the results of descriptive statistics of the study (Benatallah *et al.*, 2015) which was conducted in the same farms and at the same period by the same observer in order to identify risk factors associated to the farms degradation.

Multivariate linear models were used to estimate the association between farm characteristics and welfare criterion scores generated using the Genstat Version 15.0 Software (VSN International Ltd., UK).

We have proceeded to the calculation of the variance by applying a parametric ANOVA with LSD test fisher followed by the test of Benferroni. These tests were applied to verify the effect of each of the six characteristics on the eight criterion scores and the interactions of order 2 and 3. The significance threshold was set at $p < 0.05$.

RESULTS

The scores of the eight welfare criterion have varied according to the six characteristics of surveyed farms (geographic location, breed, herd size, housing system, type of milking and litter) (Table 1).

Absence of prolonged hunger: This criterion assessed by the percentage of very lean cow estimated through the body condition score varied depending on the breed. It shows an average score of 22.8 presenting a high state of weight loss in 81 visited farms (NEC <2) according to

Table 1: Interaction between farms characteristics and score criterion

Criterion	p-values*	Parameters model	Score ¹
Absence of prolonged hunger			
Breed	<0.001	HN breed	23.81
Breed x herd size	0.02	HN breed, herd size C	21.00
If herd size A	23.00		
Breed x housing system	0.02	HN breed, semi-hampered	22.25
Breed x location	0.02	HN, Sahel area of Algiers	21.47
Absence of prolonged thirst			
Herd size	<0.001	H size C	60.00
		If herd size A	03.00
Breed x housing system x milking type	0.03	HN, semi hampered, mechanically Milked	OA:18.47 FG:19.03
Breed x housing system x location	0.006	HN, semi hampered, Mitidja area	OA:21.26 FG:25.30
Ease of movement			
Breed x housing system x milking type	<0.001	HN, semi hampered, mechanically milked	OA:32.00 FG:34.00
Comfort around resting			
Breed x herd size	<0.001	HN, herd size C	37.00
		If herd size A	42.00
Litter x herd size	<0.001	Herd size C without litter	30.44
		If Herd size A without litter	45.00
Absence of injuries			
Herd size	<0.001	Herd size C	43.77
		If herd size A	35.29
Litter	<0.001	Without litter	35.40
		If with litter	40.50
Location	<0.001	Sahel are of Algiers	38.22
Mitidja area	40.50		
Breed, housing system, milking type	0.01	HN, hampered , mechanically milked	38.00
Absence of diseases			
Herd size	<0.001	Herd size C	22.64
Housing system	<0.001	Hampered stalls	30.00
		If free grazing	35.00
Location	<0.001	Mitidja area	27.00
		If Sahel area of Algiers	30.30
Milking type	<0.001	Mechanically milked	27.00
		Manually milked	36.00
Litter	<0.001	With litter	27.00
		If without litter	33.00
Expression of other behaviours			
Breed x herd size x housing system	<0.001	HN, herd size C, free grazing	73.37
Good human-animal relationship			
Breed x herd size x housing system	0.008	HN, herd size C, semi-hampered	26.90
		If HN, herd size, semi-hampered	42.05

HN: Holstein, Herd size C (Cows>20), Herd size A (Cows<10), OA: Outdoor loafing area, FG: Free Grazing; ¹Scorevalue estimatedby the model for the reference category of the model; *Test values (P)

the grid by Edmonson *et al.* (1989) with an average prevalence of 33% showing a disparity between the entire distributed ration, care requirements and production by surveyed cows.

Indeed, the results of the effect of breed on the body condition score ($p < 0.001$) showed that 44.6% of HN cows have a body condition score < 2 with an average of 1.50, registering a score of 23.81 against 34% regarding Mt cows with an average body condition score of 2.38, showing a score of 23.82. While Br (11%) and Fleck (10%) cows have an average body condition score of 2.10 each with a respective score of 21.55 and 22.15.

Also, the interaction (breed x herd size), showed that small (21.00) and large farms (23.00) contain a lot of HN

cows with respectively very thin body condition of 1.65 and 1.68 compared to Mt cows with respectively body condition of 2.37 and 2.26 ($p = 0.02$).

In addition, it was observed that cows with a very thin body condition, conducted more in free grassing (1.67) were mostly HN breed compared to other breeds like Mt where his body condition exceeds a score of 2 (22.25). Accordingly are more frequent in the Sahel area of Algiers (1.66) than in Mitidja area (21.47) ($p = 0.02$).

Absence of prolonged thirst: This criterion was measured based on the number of drinkers by cow, their functioning and their cleanliness, it showed that 5% of surveyed farms are provided with insufficient drinkers (one drinker per

cow), four of which are clean while one is dirty, resulting in scores between 32 and 60. Conversely, 95% of farms did not provide enough drinkers and therefore scored 3.

Indeed, the effect of herd size on this criterion, showed that large farms contain barns with automatic but insufficient drinkers (one drinker/cow) (score = 60) compared to small and average farms (score = 3) watered on a rationed basis (1-3 times a day depending on the season) ($p < 0.001$).

Also, the result of interaction (breed, housing system, geographic location) on this criterion has shown that HN and Mt breed of Mitidja area conducted in semi hindered: either on outdoor loafing area (21.26) or free grazing (25.30) are watered enough compared to the Sahel area of Algiers where most were rationed and hampered (3) ($p = 0.006$).

The interaction between (breed, housing system, milking type) and this criterion ($p = 0.03$) showed that breed HN and Mt conducted in semi-hampered and mechanically milked have recorded, respectively a high scores (OA: 18.47, GF: 19.03; OA: 17.66, GF: 33.56) compared to those treated manually (3).

Ease of movement: This criterion was determined in the welfare quality protocol by the type of housing (tied up or loose). Indeed, the protocol penalized farms conducted in tied up mode (score = 0), except if there is access to outdoor loafing area or pasture. In this case, the number of hours per day or days per year is considered. This criterion scored an average score of 23.2.

This criterion has varied with breed, herd size, geographic location, housing system ($p < 0.001$). Consequently, cows grazing are more common in livestock farming of larger sizes (34) located in Mitidja area than in small ones constantly hampered in the Sahel area of Algiers (15) ($p < 0.001$).

The effect (breed, system housing, milking type) on this criterion, shown that HN and Mt breed conducted in semi-hampered and mechanically milked have recorded high scores (OA: 32, FG: 34) compared to those conducted in hampered mode (TS: 15) ($p < 0.001$).

Comfort around resting: It has been evaluated based on 6 measurements: lying down time, lying down outside the lying down area and cleanliness assessed at three body areas (legs, udder and hindquarter), according to alarm and alert thresholds, obtained an average score of 40.8.

It varied with the herd size, housing system and litter. Indeed, interaction (breed, herd size) has shown that there is less comfort in large farms (37.53), especially with HN (37.00) and Mt breed (38.00) than in small farms (40.80) with HN (42.40) and Mt (43.10) ($p < 0.001$).

Also, this discomfort state is accentuated in large farms of Mitidja area hampered permanently compared to Sahel area of Algiers where particularly small farms suffering for discomfort.

This discomfort state is accentuated by the absence of litter in large farms (30.44) compared to small farms (45.00) ($p < 0.001$).

The time taken by the cow to lie down is the length of the lying down sequence as adopted by Lidfors (1989) the duration of lying down begins when the animal bends the lower legs and ends when it brings out these lower legs under its abdomen. The length of sleeping sequence, if it is high, reflects a difficulty for the cow to lie (Lidfors, 1989), 41% of visited farms exceeded the alarm threshold (5.20 sec \leq 6.30) and 39% of the alert threshold (> 6.30 sec), especially in Fleck (6.61 sec) and Mt (6.11 sec) followed by the HN and Br cows with a lying down time of 5.80 sec each, conducted in hampered mode ($p = 0.007$).

A link has been found between the lying down time and the herd size, litter, milking type and housing system. Indeed, the interaction (breed, herd size) showed that HN cows takes more time in lying down in large farms (6.43 sec) compared to small farms (5.71) ($p = 0.01$).

Also, the effect (breed x housing system) showed that HN cows had presented a lying down time more extended in the outdoor loafing area (6.32 sec) followed by Br (6.07 sec), Fleck (5.93 sec) and Mt (5.74 sec) ($p = 0.007$) whereas in tie stall, the Fleck (6.61 sec) and Mt (6.11 sec) have presented a prolonged lying down time compared to HN (5.78 sec) and Br (5.76 sec). Accordingly, in Mitidja area, HN cows had presented a long lying down time (6.10 sec) compared to other breeds: Mt (5.98 sec), Br (5.92 sec) and Fleck (5.73 sec) contrary to the Sahel area where Br (6.24 sec) and Fleck (6.64 sec) which had recorded a very long time of lying down followed by Mt (5.89 sec) and HN (5.85 sec) ($p = 0.01$).

For both measures cows lying outside the lying area and collisions to equipment, a small proportion of farms have exceeded the warning threshold respectively 2 and 1%. Therefore, a low average frequency of collisions (3.00%) and cows lying outside the supposed lying area (2.9%). The interaction (housing system, herd size) showed that cows lying outside the lying area were more common in large farms (22.43) conducted in hampered mode than in small (2.51) and average farms (1.23) ($p = 0.01$). Also, they are located in the Mitidja area (38.00) than in the Sahel area (1.63) ($p < 0.001$). Whereas no association was found between the collision and characteristics of farms.

Regarding the cleanliness of dairy cows, we observed a high prevalence of dirt found at udder (62.61), hind quarter (60.62) and lower part of the hind limbs (60.62).

Consequently, a large number of farms exceeded the alert thresholds for these measures: 100% for udders cleanliness, 86% for the hindquarter and 63% for the hind limbs.

Indeed, interaction (herd size, housing system and geographic location) showed that cows of small farms conducted in hampered mode (61.23) and located in Mitidja area have presented a less prevalence of dirt than in large farms (50.00) ($p = 0.04$). Also, the interaction (herd size, housing system and litter) has shown that dirt is accentuated in large farms without bedding conducted in outdoor loafing area (20.80) than in small farms (65.53) ($p = 0.04$).

Absence of injury: An association was observed between all characteristics of farms and this criterion. The effect of herd size on the injury, showed that large farms were less vulnerable to injuries (43.77) than average (38.72) and small farms (35.29) ($p < 0.001$). Also, there were more exposed to injury in farms without litter (35.40) than in farms with litter (41.30) and more common in Sahel area of Algiers (38.22) than in Mitidja area (40.50).

The interaction (breed, milking type and housing system) shown that HN breeds milked mechanically and conducted in hampered stalls (38.00) were more vulnerable to injury than those in semi hampered ($p = 0.01$).

So, injuries observed within visited farms are varying in terms of degrees and at different locations which refers to the arrangement of this criterion into two sub criteria: absence of lameness and integument alterations.

Absence of lameness: It has been estimated by the percentage of moderately and severely lame cows that they have got a score of 37.3. An average prevalence of severe lameness of 15.6% against 18.2% for moderate lameness was noted in our farms.

This severe lameness prevalence was higher in small farms (17.5) than in large farms (10.2) ($p < 0.001$) and more common in hampered stalls (18.6) than those in semi hampered stalls (OA: 10.6, FG: 13.7) ($p = 0.02$). Also, it was observed that the severe lameness frequency was greater in Mitidja area (25.5) than in Sahel area of Algiers (21.0) ($p = 0.02$). Thus, the frequency of lameness regardless of severity (moderate or severe) was observed mainly in farms conducted in hampered stalls without litter (concrete floor) (21.0) than those with litter (18.0) ($p = 0.02$).

Integument alteration: This sub-criterion reflects the prevalence and severity of various violations of the skin (moderate alteration: areas with hair loss, serious

alteration: injuries and swelling), obtained an average score of 40.8. Indeed, the average prevalence of moderate integument alteration observed in the surveyed farms was 46.6% against 22.9% of severe alterations. This high frequency of alterations is associated with herd size ($p = 0.002$). Therefore, it is higher in small farms (56.73) than in large farms (39.34).

These alterations were more common in farms of Mitidja area which opt for mechanical milking (47.00) than those in the Sahel area of Algiers (36.00) ($p < 0.001$). These factors increase the risk of injury that was higher in Mt breed (46.4) followed by HN (42.3) conducted in semi hampered.

Also, it was observed that barns with litter (41.3) and using mechanical processes (40.0) ($p < 0.001$) were more vulnerable to injury than those without litter (35.4) and manually milked (34.5).

Absence of diseases: This criterion was evaluated by observation of several symptoms. For each, the protocol defined alarm thresholds and alert thresholds; the alert threshold was half the alarm threshold. Below the alert threshold, the farm has a normal level for the said symptom considered, if the alert threshold was exceeded, the farm has a moderate problem for the symptom considered but if the alarm threshold was exceeded, the farm has a serious problem. This criterion obtained an average score of 31.9.

Indeed, the frequency of disease was less especially in small farms (37.55) than in large farms (22.64) ($p < 0.001$) and more vulnerable in hindered (30.00) than in free-grazing systems (35.00) ($p < 0.001$). Thus, mechanically milked (27.00) than manually (36.00) ($p < 0.001$). As well, the cases of diseases were more frequently in farms with litter (27.00) than without litter (33.00) and in Mitidja area (27.00) than in Sahel area of Algiers (30.30) ($p < 0.001$).

Indeed, these diseases were more linked to the reported cases of mortality (10.4%), the frequency of respiratory diseases associated with cough (15.6%) and especially to mastitis (33.6%).

An association between the characteristics of farms and percentage of mastitis was observed in the visited farms. Indeed, large farms have shown a high percentage of mastitis (40.10%) compared to small farms (28.0%) ($p < 0.001$).

Also, the interaction (housing system and milking type), showed that farms conducted in loose housing and mechanically milked (OA: 37.26; FG: 30.86) were exposed more to mastitis risk compared to those conducted in hampered stalls and manually milked (41.23) ($p = 0.03$).

On the opposite, no association between the characteristics of farms and cases of respiratory diseases associated with cough.

Indeed, cases of mortality were higher in farms without litter and manually milked (5.04) compared to those with litter and mechanically milked (12.03) (0.01).

Other pathologies detected in the farms visited at low frequencies: diarrhea problems (3.6%), dystocia (2.3%) and lying cow syndrome (4.4%) have varied according to the characteristics of farms. Consequently, they were common more in small (2.00) and large farms (3.00) than in medium sized farms (6.00) ($p = 0.04$) as well as those using mechanical milking (5.00) and equipped with litter (5.50) ($p = 0.01$). Cases of dystocia recorded during the past 12 months have revealed an association between the housing system and geographic location. Indeed, these cases were higher more in farms of Mitidja (0.79) conducted in tie-stalls than those of the Sahel area of Algiers conducted in tied stalls (4.00) ($p = 0.04$).

While the cases of lying cow syndrome were more pronounced in large farms (3.07) compared to small farms (6.54) ($p = 0.04$).

Expression of other behaviors: This criterion was assessed by the accessibility of pasture (based on the number of days per year during which the cows have access to pasture for at least 6 h), recorded an average score of 12.6. It was varied with all the characteristics of farms ($p < 0.001$).

Indeed, the interaction (breed, herd size, housing system) revealed that HN breed of large farms (73, 37) spend less time in the pasture and the rest of the year are hampered ($p < 0.001$).

Good human-animal relationship: This criterion evaluated through the avoidance distance test towards a foreign person, taking into account the distance at which cows can be approached. It obtained a score of 34.3 which was explained by the high prevalence of cows fleeing at a distance between 50 and 1 m (47.7) followed by those fleeing from 0 and 50 cm (30.3). Link has been found between herd size, breed, housing system and this criterion. It showed that HN breed of small farms (42.05) conducted in free grazing were presented a less state of fear than those of large farms (26.90) ($p = 0.008$).

DISCUSSION

This study is the first in North Africa (Algeria) to identify the relationship between the characteristics of dairy cows and several aspects of welfare apprehended together by the Welfare Quality® Assessment Protocol.

Indeed, the association between aspects of welfare relevant to health, feeding, behavior, housing and

characteristics of surveyed farms (location, breed, herd size, housing system, type of milking and litter), revealed considerable variability between the surveyed farms (large and small) reflecting a divergence in the conduct and management of these farms. Thus, undeniable efforts must be made to limit their degradation by adopting action plans focusing on these risks.

Regarding 'absence of prolonged hunger' the lowest scores among all farms were found for Holstein cows conducted in free grazing of Sahel area of Algiers that shown a very thin body condition. The high percentage of lean cows was closely related to this dairy breed that was often associated with a loss of body reserves during lactation and difficulty to recovering those reserves at the end of lactation or at dry off.

Our results were consistent with those by Coignard *et al.* (2013) and Gilot-Formont and Mounier *et al.* (2014) that have shown that the percentage of lean cows was closely related to HN breed. This food shortage was exacerbated by the drinking problem that was mostly rationed particularly in small and average farms hampered of Sahel area of Algiers which reflects the very low scores (5.9) of this criterion.

This was explained by the fact that the Mitidja area contains the most potential subdivisions not only from the point of view of staff but also from the point of view of surface area, most practicing free grazing compared to the Sahel area of Algiers which contains small farms conducted in tied up mode.

This type of watering (rationed) does not meet, on the one hand, water needs of dairy cows and secondly, results in a reduction in metabolism, intake capacity, cow weight and milk production (Andersson, 1987; Coignard *et al.*, 2013). Tucker *et al.* (2006) showed that a slight under-watering reduced immediately the production performance and therefore, the efficiency of use of feed resources of which production needs water consuming.

For this, special attention is required to assess the actual water needs of surveyed cows especially in particular climatic conditions of North Africa (high temperature with a high rate of humidity) which tends to climate dryness associated with the lack of water resources and fodder. As a result, the negative impact on productivity, adaptability and welfare dairy cows.

Housing system was the second risk factor altering the welfare of cows because most stables were hampered and ill-conditioned (dark, damp, slippery abrasive, space allowance) which not only limits the freedom of animals to express their natural behaviour but contributes to the appearance of pathologies (lameness, mastitis, respiratory problems and infertility) that affect their welfare and

threatens their sustainability. These attacks confirm the results of previous studies that identify these aspects as major welfare problems (Zurbrigg *et al.*, 2005).

Our values were similar to those by Tucker *et al.* (2009) which registered >50% of tie-stall barns in England and confirms the report which showed that operating systems used (stall) were the major risk that affects the health and welfare of dairy cows.

Also, the housing system had significant effects on the scores for: comfort around resting, injury, diseases and expression of others behaviours'. Thus, this state of discomfort accentuated in large farms hampered permanently are related essentially to the lying down time prolongation to a strong state of dirt in the majority of visited farms and then to the problems of collision and lying outside lying area.

This elongation is due to the mismatch between the fitting of the sleeping area and the movement of sleeping of cows following the shortening of the restraining chain that hinders its sleeping. Also, due to farming practices (absence of mulching or wet and slippery sleeping area), presence of lame cows suffering from mastitis and thus, experiencing great pain when lying down. Our results confirmed the opinion of experts (Doherr *et al.*, 2007).

The lowest percentage of cows lying outside lying area and collision to equipment are related to the fact that cows bump less with infrastructure (feeders, drinkers) in the absence of separation between them and to the mismatch between the sleeping area and the cow's size. These frequencies were similar to those by Coignard *et al.* (2013).

Likewise, the high percentage of dirty cows refers to a degraded environment of the animal (wet lying area, slippery without litter or tick indicating poor health conditions. This discomfort state favors the occurrence of injuries and diseases (lameness, mastitis and respiratory diseases). As a result, it increases the states of pain and suffering thus altering the well-being of visited farms.

For 'absence of injuries', HN breed of small farms conducted in hindered stalls without litter and mechanically milked of Sahel area of Algiers were more vulnerable to injuries than in large farms of Mitidja area milked manually. These associations reveal the lack of control and monitoring at the level of small farms and show that cows in hindered stalls without litter were more exposed to injuries and to the risk of developing diseases because the bare, concrete and cracked floor is a source and a cause of pain of injury and of disease (arthritis, tarsites, fractures, ...). Also, our results confirm those by Haskell *et al.* (2006) which showed that housing is a risk factor for skin alteration and bad milking practices (related to poor adjustment and maintenance of the

milking machine, milking equipment not suitable (sleeves) or poorly designed (slope, looping, ...) encourages teat injuries and predispose to health problems (mastitis). Also, hard concrete surfaces encourage alterations of skin and increase frequency of injury.

Accordingly, it has been shown that soil conditions have an impact on the rating of locomotion or the proportion of clinical lameness (Gilot-Fromont and Mounier *et al.*, 2014). This meets not only the scientific opinion by EFSA Reports which reported higher risks of lameness factors in stanchion barn but also Rushen *et al.* (2007). As a result, cows frequently exposed to concrete floors without litter were more exposed to suffering from lameness (Burgos *et al.*, 2001) which confirms the study (Gilot-Fromont and Mounier *et al.*, 2014) which showed that the state of soil affects the score locomotion or the proportion of clinical lameness.

The scores for 'absence of diseases' were low in almost all the farms and were linked to the reported cases of mortality (10.4%), the frequency of respiratory diseases associated with cough (15.6%) and especially to mastitis (33.6%). Thus, the scores vary according to farm characteristics. Indeed, the high percentage of mastitis was more vulnerable in large farms conducted in loose housing and mechanically milked. This is explained partly by the lack of maintenance and milking equipment hygiene and lack of use of individual cloths for each cow which is a quick way of contamination.

Also, they were related to poor cleanliness of surveyed cows, seen mainly on cow teats (100%) which were very susceptible to infections. These cases of mastitis were increased with milk production especially high producers (Holstein). Our results confirm the opinion by Doherr *et al.* (2007) which has shown a poor condition of cleanliness of animals and milk production were a risk factor for mastitis.

On the opposite, no association between the characteristics of farms and cases of respiratory diseases associated with cough were reported in the farms visited. This may be related to other factors such as environmental conditions (bad ventilation, darkness, bare soil, draught).

The low cases of dystocia were related to the fact that the majority of these farms were small, highly dependent on the external market in terms of food and weak in front of economic fluctuations. Therefore, very lean body conditions that expose them to difficulties in calving.

The lowest scores of 'expression of other behaviours' was related to the limited number of farms that practice free-grazing (19 farms with a minimum of 6 h/day and a maximum of 12 h/day).

The scores for 'good human-animal relationship' were variables among farms; this variability was explained by farm characteristics. Small farms conducted in free grazing having HN breed were presented less fear than large farms. These results demonstrated a relative state of fear in most of the surveyed farms. This state has adverse consequences on livestock, breeders and consumers. Indeed, fear, whether sudden, severe or prolonged, seriously damages the welfare and productivity as well as meat quality (Rushen *et al.*, 2007).

Our results were similar to those of the study (Weary and Tazskun, 2000) which showed a link between the herd size, breed and the human-animal relationship. On the other hand, they were contrary to those by Gilot-Fromont and Mounier *et al.* (2014) which have found no link between the characteristics of the farms visited and the score regarding the relationship between animal and man.

CONCLUSION

This study allowed for the first time under conditions encountered in North Africa to analyze the risk factors that affect the welfare of dairy cows apprehended by the Welfare Quality Assessment Protocol. It focused on the association between the characteristics of the farm (herd size, breed, housing system, location, type of milking and litter) and the scores of welfare criterion. Thus, herds constantly hampered without litter are prone to discomfort problems, injuries and diseases. Also, Holstein cows with very thin body condition and with a rationed watering and mechanically milked constitute another risk factor. These sub-populations at high risk constitute alert indicators for a prospect of improvement. Finally, a significant degree of variability regarding interference with the well-being were found between farms surveyed (large and small), referring to a divergence in the conduct and management of these farms.

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