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Effect of Nutrition and Temperature Humidity Index on The Performance of Lactating Holstein Cattle

Lasheen, M. E.; M. A. Safwat and S. A. Elsaadawy
Department of Animal Production, Faculty of Agriculture, Al-Azhar University, Cairo-Egypt.

ABSTRACT

Nine hundreds of lactating Holstein cows in three locations (300 cows at each location) were used to evaluate the effect of nutrition and temperature humidity index (THI) conditions on dairy cattle performance (milk production and composition, digestibility, rumination, rumen pH). Three rations (chemically varied in physical effective NDF (peNDF), neutral detergent fiber (NDF), starch, dietary cation anion difference (DCAD), forage to concentrate ratio (F:C), crude protein (CP), either extract (EE), acid detergent fiber (ADF) and non fiber carbohydrates (NFC) were used at the three locations (R1 in L1, R2 in L2 and R3 in L3). Reviewing the nutritional and THI conditions of dairy farming systems in three countries in the Middle East and provides an up-to-date description of farming systems in these countries. Due to the common dairy farming problems in the region, the study focuses on three countries: Sudan (L1), Lebanon (L2) and Kuwait (L3) for an in-depth evaluation of the nutritional and THI conditions of dairy farming systems. The results indicated that increasing the intake of peNDF increase rumination and ruminal pH, but did not affect intake of DM or NDF. So, the models of those predict rumen pH should include both peNDF and fermentable organic matter (OM) intake. Dietary particle size expressed as peNDF, was a reliable indicator of rumination activity. The digestibility of dry matter (DM), CP, EE and NDF increased as concentrations of CP and NFC increased in the ration. While, the digestibility of OM, NFC and ADF was decreased. Milk production and composition negatively affected by increasing of THI. As the THI increased from 63 to 76; the animal performance decreased either in dry matter intake (DMI) and milk production and composition.

Keywords: Nutrition, milk production, temperature humidity index, rumen pH, rumination and digestibility.

INTRODUCTION

Dairy cattle production is an important component of the food industry. Nutrition is a key factor in the performance, health and welfare of dairy cattle. The large variation in dairy cattle production is dependent on the nutrition and the various environments in which they are maintained. The animal producers must increase concern toward optimizing feeding programs and management (NRC, 2001). Many researchers studied the effects of nutritional conditions on animal performance, especially the dietary protein as a one of the critical factors in dairy nutrition necessary to maximize production. Broderick (2003) reported a linear increase in dry matter intake (DMI), milk yield, fat corrected milk (FCM), fat and protein content and protein yield when dietary crude protein (CP) was increased from 15.1 to 16.7%. The average CP content of the lactating cow diets in high producing Western dairy herds was 17.6% (Hristov et *al.,* 2006). While, Caraviello *et al.* (2006) reported that CP in the diet fed to dairy cattle was 17.8 ± 0.1% DM basis.

Carbohydrates are the major source of energy in the diets fed to dairy cattle and usually comprise 60-70% of dry matter. The main function of carbohydrates is to provide energy for rumen microbes and the host animal, and is to maintain the health of the gastrointestinal tract. Fiber carbohydrates (neutral detergent fiber, NDF and physically effective NDF, peNDF); The NDF digestibility is more variable than the digestibility of any other feed component and can profoundly affect DMI and milk production. Fiber digestion is affected by characteristics of the plant material and by the animal consuming the fiber (Combs, 2016). peNDF is related to the physical characteristics of NDF (primarily particle size) that affect chewing activity and contributes to the floating mat of large particles in the rumen (Mertens, 1997, 2002). Dairy cows fed equivalent forage NDF concentration from different sources had similar milk yield 35.6 kg/d, milk fat 3.56% and milk protein 2.87% (Eastridge *et al.,* 2017). Several studies are conducted to study the relationship between changes in peNDF and feed intake, chewing and ruminal pH of dairy cows (Yang and Beauchemin, 2005 and 2006 a,b).

Sugars, starches, organic acids and other reserve carbohydrates such as fructans make up the non-fiber carbohydrates (NFC) and the ruminal fermentation of NFC varies greatly with type of feed and conservation and processing methods (NRC, 2001). Feeding more fermentable diets during early lactation does not decrease DMI or negatively impact on other aspects of animal performance (Dann and Nelson, 2011).

High concentrate: forage ratio (C: F) levels often decrease milk fat content, increasing in C:F ratio frequently increases milk protein content (Aguerre *et al.*, 2011 and Neveu *et al.,* 2013). Higher forage rations have additional benefits, including higher milk components, improved income over purchased feed costs, better rumen health, lower purchased feed costs, less foot problems and increased cow longevity (Chase and Grant, 2013).

DMI and lactating performance of dairy cows may be increased as dietary cation–anion difference (DCAD) increased (Hu and Murphy, 2004 and Sharif *et al.,* 2010). The ruminal pH linearly increased according to DCAD increase from −71 to 290 mEq/kg DM, which results in a higher ruminal digestion of NDF, as ruminal concentrations of acetic acid and NDF total apparent digestibility increases as DCAD increased (Martins *et al.,* 2016).

The majority of studies on heat stress in livestock have focused mainly on temperature and relative humidity (St-Pierre *et al.,* 2003; West *et al.,* 2003 and Correa-Calderon *et al.,* 2004) because data of temperature and humidity records can be usually obtained from a meteorological station located nearby. Increases in temperature combined with increased maintenance requirements as a consequence of heat stress which mean that producers should stay alert to cattle energetic and nutritional requirements, falling below these levels even in temperate regions (Baumgard and Rhoads, 2012). Number of studies have reported declines in milk yield and quality with increasing THI (Dunn *et al.,* 2014; Moons *et al.,* 2014 and Hill and Wall, 2015). The aim of this study is carried out to evaluate the performance of lactating Holstein cattle in some large-scale commercial dairy farms in some Arabic countries at the first 100 days of lactation.

MATERIALS AND METHODS

Cows were cared and handled in accordance with the Guide of Care and Use of Agricultural Animals in Agricultural Research and Teaching (FASS, 1999).

Cows, feeding and experimental design

The study population consisted of 900 multiparous lactating Holstein cows from three large commercial dairy herds (300 cows/ herd) in three Arabic countries: Sudan (herd 1), Lebanon (herd 2) and Kuwait (herd 3). Cows were weighting 600- 650 kg of body weight (BW). The animals were assigned to three experimental treatments (three hundred animals for each treatment at three different countries). The dairy cows were maintained in free-stalls. Animals diets were offered as total mixed ration (TMR) twice daily at 6.00 a.m. and 6.00 p.m. The feed was delivered to animal on feed bunk by mixer wagon. The fresh water was available to animals continuously. Feed intake was recording daily. According to the dairy projects feeding regime three rations were used in this experiment (one ration for each treatment). TMR composition, chemical analysis of rations and ingredients are shown in Table (1).

Digestibility trials

Three digestibility treatments were applied at the last week of experimental periods (100 days). Five percent from the cattle in each experimental group were used in the digestibility trials. Feces samples were collected directly from the rectum at 8.00 am during the last week of each experimental period. Solution of 10% H_2SO_4 and solution of 10% formalin were added to the representative samples then dried in oven at 60^{o}C for 24 h. Lignin was used as an internal indigestibility marker, and coefficients of digestion calculated according to Czerkawski (1967). The dried feces samples from each animal were mixed and stored at –18^o C for chemical analysis.

Feed samples (TMR) were taken monthly. The composited samples were dried at 55°C for 48h and then ground through a 1-mm diameter screen (standard model 4, Arthur Thomas Co., Philadelphia, PA) for analysis of EE, NDF, ADF, starch, NFC, peNDF, NEL, CP, DCAD and ash. One kilogram of each TMR was obtained monthly. peNDF of the TMR was determined using the Penn State Particle Separator (PSPS) containing 2 sieves (19 and 8 mm). The DM content was analyzed by drying at 55°C for 48 h. The samples were then composited by experimental period and retained for determination of chemical composition. These analyses were conducted commercially by Rock River Laboratories, Watertown, WI. Total digestible nutrients (TDN) and net energy for lactation (NEL) were calculated according to NRC (2001). Dietary cation-anion difference (DCAD) was calculated according to the Equation of Ender *et al.* (1971).

DCAD = $(Na^+ + K^+) - (Cl^- + S^{-2})$ mEq/kg DM.

Where: mEq- milliequivalents per kilogram dry matter.

Table 1. Chemical analysis of ingredients and experimental total mixed ration (TMR) fed to the Holstein cows (% DM basis).

Item	Ingredients										Treatments[1]		
	AH	CS	GCG	SBM	BPP	WB	CTS	MSC	SS	CM	R1(L1)	R2(L2)	R3(L3)
DM	90.0	30.0	93.0	92.0	91.0	88.8	92.0	73.0	30.0	90.2	50.0	50.1	50.1
OM	90.0	95.7	98.7	93.8	94.4	93.2	95.8	89.0	89.1	92.0	92.0	90.5	92
NDF	46.0	49.0	9.0	13.7	43.3	45.0	50.3	0.0	63.9	27.7	33.8	29.1	27.3
peNDF	36.1	39.2	5.85	6.85	21.65	19.8	60.0	0.0	53.8	11.8	26.81	22.40	21.69
ADF	36.3	24.30	3.70	8.70	26.5	15	25.0	0.0	41.2	20.4	22.2	20.5	18.5
NFC	24.5	35.4	77.5	16.7	40.7	29.7	3.4	82.2	12.4	18.0	36.5	38.7	42.2
CP	17.0	8.1	8.5	41.7	8.8	14.0	23.5	5.8	9.4	41.5	15.0	17.1	15.4
EE	2.5	3.2	3.7	1.7	1.6	1.5	1.8	1.0	3.4	4.8	6.7	5.7	7.1
Ash	10.0	4.3	1.3	6.2	5.6	6.8	4.2	11.0	10.9	8.0	8.0	9.5	8.0
NEL, Mcal/kgDM	1.7	1.4	2.0	2.7	1.4	1.6	1.5	1.8	1.0	1.8	1.6	1.6	1.7
Starch	1.4	30	75.6	4.4	3.6	17.6	0.49	00	2.8	2.6	23.4	14.3	15.8
Forage	100	100	0	0	0	0	0	0	100	0	60.2	50.3	50.8
DCAD (mEq/kgDM)											300.0	350.0	300.0

AH= alfalfa hay; CS= corn silage; GCG= ground corn grain; SBM= soybean meal; BPP= beet pulp pelleted; WB= wheat bran; CTS = cotton seed meal; MSC= molasses, sugarcane; SS= sorghum silage and CM= canola meal.

[1] The cows were fed a TMR containing (% DM) 20.23, 39.57 and 34.72% alfalfa hay, 33.78, 10.74 and 16.03% corn silage, 15.48, 13.15 and 13.08% corn grain, 9.68, 6.78 and 11.30 % soybean meal, 2.45, 2.93 and 1.44% minerals and vitamins mixture[2], and 1.83, 6.67 and 9.83% molasses in rations R1, R2 and R3; respectively. The ration 1 also contained 6.22% sorghum Sudan silage, 5.51% cotton seed meal, 2.76% wheat bran and 2.06% others. The ration 2 also contained 2.42% beet pulp pellets, 8.68% canola meal, 5.98% glycerol and 3.08% others. The ration 3 also contained 2.61% Canola meal, 7.81% glycerol and 3.18% others.

[2] Min. &Vit. Mix. contained: limestone ground 36.58%, sodium carbonate 26.6%, sodium bentonite 9.97%, white salt 6.65%, magnesium oxide 6.65%, rumensin 0.227% and vitamin 13.3% (Vit. A 2.400.000 IU/Kg, Vit. D3 804.000 IU/Kg and Vit. E 10.000 IU/Kg).

Rumination and ruminal pH

Visual observance is a measurement method used to determine the chewing and rumination activities of cattle through counting jaw movements per minute daily by human observers, usually with a hand-held counter or a stopwatch (Burfeind *et al.,* 2011 and Schirmann *et al.,* 2011). Monitoring reticuloruminal pH, an indwelling and wireless data transmitting system (SmaXtec animal care

GmbH, v3.3.0) was used (Gasteiner *et al.,* 2009 and 2012). The values were taken before the morning feeding (0 time) and at 6 h, after the morning feeding.

Temperature humidity index (THI):

THI was calculated according to National Research Council formula NRC (1971).

THI = (1.8 × Tdb + 32) − (0.55 − 0.0055 × RH) × (1.8 × Tdb − 26); where: Tdb – dry bulb temperature (°C) and RH – relative humidity (%).

Milk sampling and milk composition analysis

Milk yield was recorded computerized daily by session at morning and evening during the experimental periods by the ALPRO HERD MANAGEMENT SOFTWARE (V: 7.2) Delaval Corporation, Sweden. Samples of milk were collected from bulk tank to determine the chemical analysis at milk plant laboratory for analyses of milk fat, total solids (TS), solids not fat (SNF) and total protein (TP) using MilkoScan FT120 system, Foss- Denmark.

The 4% fat corrected milk (FCM) was calculated according to Gaines (1928).

4 % FCM (kg/d) = 0.4 x milk (kg/d) + 15 x fat (kg/d).

Energy corrected milk (ECM) was calculated according to Misciattelli *et al*. (2003).

ECM (kg/d) = (milk kg × (0.383 × % fat + 0.242 × % protein + 0.7832) / 3.14).

Statistical analyses

The collected data were statistically analyzed by SAS (2004) using the following model: $Y_{ijl} = +R_i + L_j + (RL)_{ij} + E_{ijl}$; Where: expressed the general mean, Y expressed the every observation of the *j*th location in the given *i*th ration, R_i expressed the ration effect, L_i expressed the location effect, $(RL)_{ij}$ expressed the effect of the interaction between ration and location, and E_{ijl} expressed the experimental error. Duncan's multiple test (Duncan, 1955) was used to separate among means. Significance was declared at a level of $P \leq 0.05$.

RESULTS

Feed intake and nutrient digestibility

Cows fed the second ration (R2) (significantly, P≤0.05) consumed more DMI than cows fed the first and the third rations (R1 and R3). Moreover, the presented results clearly showed that the digestibility coefficient of OM, CP, NFC and ADF were highest *(P*≤0.05) at third location compared to other locations. Except for DM, EE and NDF which were higher (*P*≤0.05) at second location than those of the first and third locations (Table 2).

Rumination and ruminal pH

Cows fed R1 recorded the highest (*P*≤0.05) rumination number compared to cows fed R2 and R3, respectively. Regards to ruminal pH at zero time (before feeding) and 6hrs (post feeding) cows fed R1 recorded the highest (*P*≤0.05) value compared to cows fed R2 and R3 (Table 3).

Milk yield and composition

Cows fed R2 produced highest (*P*≤0.05) milk yield, FCM yield, peak of milk and milk constituent (fat, protein and total solids) output and SNF yield compared to cows fed R1 and R3. The number of days reach to the peak for the cows fed R2 recorded the lowest followed by cows fed R1 and R3. While the highest (P≤0.05) SNF content reported in cows fed R1compared to cows fed R2 and R3 (Table 3). The feed efficiency ratio (kg milk /kg DM intake) recorded the highest (*P*≤0.05) value for cows fed R2 compared to those of cows fed R1 or R3 (Table 3).

Table 2. Feed intake, nutrient digestibility and nutritive value of diets fed to the Holstein cows.

Item	Treatments		
	R1	R2	R3
Dry matter	20.11^{b}	20.50^{a}	19.65^{c}
Digestibility (%):			
DM	66.40±0.040^{c}	68.19±0.044^{a}	67.67±0.042^{b}
OM	66.71±0.029^{c}	68.79±0.004^{b}	69.12±0.084^{a}
CP	66.68±0.007^{b}	68.61±0.007^{a}	68.76±0.096^{a}
EE	64.10±0.063^{b}	66.23±0.066^{a}	63.47±0.107^{c}
NFC	70.27±0.035^{c}	71.34±0.361^{b}	71.68±0.267^{a}
NDF	64.87±0.010^{c}	66.39±0.163^{a}	66.16±0.158^{b}
ADF	57.68±0.133^{b}	57.48±0.126^{b}	58.24±0.139^{a}
Digestible nutrients and energy value*			
Total digestible nutrients (%)	70.00±0.418^{b}	70.00±0.354^{b}	71.00±0.524^{a}
Net energy of lactation (Mcal/kg DM)	1.61±0.029^{b}	1.58±0.032^{b}	1.71±0.017^{a}

R1used in L1, R2 used in L2 and R3 used in L3; where: THI were 76, 63 and 73 in L1, L2 and L3 respectively.

*Calculated according to NRC (2001). Means in the same row with different superscripts differ, $P < 0.05$.

DISCUSSION

Feed intake and nutrient digestibility

Increasing dietary protein and dietary cation–anion difference (DCAD) with decreasing the dietary fat, starch and forage (Table 1) resulted in increasing DMI for cows fed R2 compared to cows fed R1 and R3 (Table 2). These results were in agreement with those found by Law *et al.* (2009) for dietary protein, Schauff and Clark (1992) for dietary fat, Johnson and Combs (1992) for dietary forage, Broderick *et al.* (2008) for dietary starch and Martins *et al.* (2015) for DCAD.

The digestibility of OM, CP, NFC and ADF were the highest (*P*≤0.05) for cows fed R3 (lower in ADF, NDF and peNDF; higher in NFC and fat) compared to cows fed R1 (lower in CP; higher in starch, forage, ADF, peNDF and NDF) or R2 (lower in fat, starch and forage; higher in CP and DCAD). DM, EE and NDF digestibility were higher (*P*≤0.05) for cows fed R2 than those fed the first and third rations (Tables 1 and 2). Palmquist and Conrad (1978) found that high fat diets increased digestibility of EE and did not reduce digestibility of any other nutrients. Also, in some cases fat increased digestibility of crude protein. Digestibility of ADF was increased with no significantly. Broderick and Radloff (2004) found that decreasing starch from 31.5 to 23.2% DM in cattle ration linearly increased the digestibility of DM, OM, and NDF. As DCAD increased from 300 to 350 mEq/kg DM, NDF digestibility increased. Martins *et al.* (2016) observed a linear i ncrease of NDF total apparent digestibility by 6.38% as DCAD increasing from −71 to 290 mEq/kg DM.

Rumination and ruminal pH

Increasing of NDF from 27.28 to 33.81 resulted in increasing of rumination from 52 to 62 (Tables 1 and 3). Beauchemin (1991) reported that increasing the number of chewing cycles increases fibre content of the ration. Cows fed a ration with larger forage particles may respond by increasing the rumination by increasing the number of chewing cycles per cud (Yang and Beauchemin, 2006 a and b). However, Beauchemin and Yang (2005) Increasing intake of ration peNDF increased rumination and chewing activity for cattle fed ration mainly corn silage as forage source. Trösch (2013) and Braun *et al.* (2015) found that the mean number of chewing cycles per cud for lactating Holstein cattle ranged from 43 to 69 chewing cycles per cud.

The highest value of rumen pH recorded at zero time (before feeding) and decreased at 6 hrs. (post feeding). May be attributed to the intensive fermentation process of both non-structural and structural carbohydrates. the highest pH values recorded at the zero time and decreased after feeding for a period of a few hours, and then increases again because of rumination, and salivation are reflect the lowest volatile fatty acid (VFA) concentration at the same time, the increase of VFA caused decreased in pH value (Beauchemin and Yang, 2005 and Palmonari *et al.,* 2010). Beauchemin *et al.* (2003) observed that diets with higher peNDF concentration resulted in higher ruminal pH values. While, Beauchemin and Yang (2005) found that increasing chewing activity due increased ration peNDF did not significantly changed ruminal mean of pH. The results showed that the lowest and highest ruminal pH (6.29-6.51 and 5.99-6.19) at (0 and 6 hrs.), respectively using R3. Batajoo and Shaver (1994) found that decreasing starch from 32.9 to 17.6% DM linearly increased ruminal pH. The DCAD 300 mEq/kg DM (R1) recorded the highest ruminal pH 6.51-6.19 before and after feeding (Table 3). Apper-Bossard *et al.* (2010) reported that DCAD did not change the mean of ruminal pH, when studied the effects of two levels of dietary concentrate (20% or 40% DM) and three levels of DCAD 0, 150 and 300 mEq/kg DM on ruminal metabolism of dairy cows.

Milk yield and composition

Cows fed R2 produced highest ($P \leq 0.05$) milk yield, FCM yield, peak of milk and milk constituent (fat, protein and total solids) output and SNF yield compared with cows fed R1 and R3. The number of days to peak for the cows fed R2 recorded as lowest number followed by cows fed R1 and R3. While the highest ($P \leq 0.05$) SNF content reported in cows fed R1compared to cows fed R2 and R3 (Table 3). Colmenero and Broderick (2006) found that using CP ranged from 13.5 to 16.5% reported that milk yield increased as CP increased. In NRC (2001); the increasing of CP from 15.1 to 18.4% had positive effects on FCM yield. Caraviello *et al.* (2006) reported that the fat level in dairy cattle ration should not exceed 6–7% of DM and Palmquist and Conrad (1978) found that 4% FCM was higher with high fat diets. Chase and Grant (2013) found that the milk production ranges from 34.2-47.25 kg milk/cow/day with rations containing > 60% forage as DM basis and total ration NDF ranges from 31-34%, while forage NDF is ranged from 23 to 30% of the total ration DM. Ranathunga *et al.* (2008) reported that as the starch content in lactating cows ration decreased from 28.0 to 17.5%, there was no effect of diet on milk yield. Martins *et al.* (2015) they indicated that milk yield increased quadratic with increasing DCAD from −71 to 290 mEq/kg DM. Tucker *et al.* (1991) reported that 4% FCM production tended to be highest for cows fed DCAD 150 diet, The tendency for elevated 4% FCM yield for DCAD 150 ration may be related to improved nutrient digestibility in the rumen.Yang and Beauchemin (2007) and Aguerre *et al.* (2011) reported that the increasing of F: C ratio is associated generally with higher milk fat%. Colmenero and Broderick (2006) reported that the milk fat output increased linearly with increasing CP. Huhtanen and Shingfield (2005) found that increasing CP from 16.1 to 18.9%; increased fat yield significantly. Broderick *et al*. (2008) found that feeding dairy cattle ration containing 21.5, 24.5, 27.4 and 28.2% starch as DM basis, decreasing starch content linearly increased milk fat output. Martins *et al*. (2015) reported that fat content was increased linearly by 8.78% according to DCAD increases from −71 to 290 mEq/kg DM and Hu and Murphy (2004) and Chan *et al.* (2005) found that milk fat yield was unaffected by DCAD.

Leonardi *et al.* (2003) found that the milk protein yield unaffected when dietary CP increased from 16.1 to 18.9%. Aguerre *et al.* (2011) showed that increasing of F: C ratio is associated generally with decrease in milk protein output. Martins *et al.* (2015) reported that protein content reduced linearly by 4.83% while total solids content increased linearly by 2.6% when DCAD increases from −71 to 290 mEq/kg DM. Chan *et al.* (2005) studied the effect of feeding fresh cow ration with difference in DCAD ranged from 200, 350, to 500 mEq/kg DM on milk yield; no differences were observed for output of milk protein. While, Wildman *et al.* (2007) demonstrated that the milk protein concentrations increased when DCAD increased. Colmenero and Broderick (2006) found that the milk SNF increased linearly with increasing CP of the diet.

As THI increase 63, 73 and 76 as milk protein content decrease (3.58-3.08%), in first, second and third rations, respectively; these results were in agreement with those reported by Bruegemann *et al.* (2012) and Hammami *et al.* (2013). Dunn *et al.* (2014) and Moons *et al.* (2014) reported declines in milk yield and quality with increasing THI in temperate regions, highest milk yield were obtained when THI was ~55 units, The rate of decrease in milk yield was greater at higher values of THI than at lower values. Collier *et al.* (2011) and Gantner *et al.* (2011) reported highly significant (P<0.01) decrease of daily milk yield due to increasing of THI. Hill and Wall (2015 and 2017) found decreased milk and fat corrected milk yields and quality as THI increased. Decreases in DMI under conditions of heat stress are associated with decreases in daily and resting metabolic heat production, longer digestion times, and a shift from fat to glucose utilization in dairy cows (Eslamizad *et al.,* 2015).

Table 3. Ruminal pH, rumination and milk yield and composition recorded for the Holstein cows.

Item	Treatments		
	R1	R2	R3
Ruminal pH			
0 h	6.51±0.007^a	6.32±0.006^b	6.29±0.008^c
6 h	6.19±0.008^a	6.10±0.005^b	5.99±0.007^c
Rumination (number of chewing cycles per cud)			
3 h	62±0.684^a	55±0.665^b	52±1.140^c
Milk production (kg/d)			
Milk yield	23.00±0.252^b	27.69±0.246^a	23.35±0.204^b
Energy corrected milk ECM	20.98±0.227^c	27.80±0.266^a	22.98±0.196^b
Fat corrected milk FCM	21.57±0.234^c	27.45±0.242^a	22.94±0.198^b
Peak of milk			
Days to peak (d)	42.17±9.112^a	5.59±3.552^b	6.59±4.926^a
Milk components (%)			
Fat	3.57±0.013^c	3.94±0.006^a	3.87±0.010^b
Protein	3.01±0.050^c	3.54±0.036^a	3.44±0.031^b
Solids not fat	7.04±0.013^a	6.83±0.006^b	6.70±0.019^c
Total solids	10.61±0.017^b	10.77±0.011^a	10.57±0.027^c
Milk component yield (kg/d)			
Total solids	2.45±0.027^b	2.98±0.026^a	2.47±0.021^b
Solids not fat	1.62±0.018^b	1.89±0.017^a	1.57±0.014^c
Fat	0.82±0.090^c	1.09±0.010^a	0.91±0.008^b
Protein	0.69±0.008^c	0.98±0.009^a	0.80±0.007^b
Feed efficiency			
Milk (Kg milk/DM intake)	1.14±0.012^c	1.35±0.012^a	1.19±0.010^b

Means in the same row with different superscripts differ, (P≤0.05).

The feed efficiency (milk kg /Kg DM intake) calculated to cows fed R2 was significantly (P≤0.05) the highest compared to those calculated for cows fed R1 or R3, as 1.14, 1.35 and 1.19 kg milk/kg DM, respectively (Table 3). Hutjens (2004) reported that fibre intake and level are reduced feed efficiency. Britt *et al.* (2003) found a negative correlation between feed efficiency an, forage %, NDF% and kilograms of forage and ADF in the diet. Broderick *et al.* (2008) reported that as starch decreasing from 28.2% to 21.5% DM basis as feed efficiency linearly decreased. Aguerre *et al.* (2011) reported that the increasing F: C ratio in the diet had no effect on feed efficiency ECM/ DM intake 1.81 ± 0.18. Martins *et al.* (2015) reported that feed efficiency (milk kg/DMI) was reduced in a quadratic form with increasing DCAD from −71 to 290 mEq/kg DM.

CONCLUSION

The digestibilities of organic matter dry matter, protein and non fiber carbohydrate (NFC) was increased as concentrations of crude protein and non fiber carbohydrate increased in the ration. While, the digestibility of ether extract and neutral detergent fiber fellow a different trend. Rations with adequate level of physically effective NDF resulted in maintain ruminal pH stability in high producing dairy cattle and increase rumination. Milk production, fat corrected milk, energy corrected milk and milk composition was negatively affected by increasing of temperature humidity index (THI). As THI increased from 63 to 76; as the animal performance decreased either in dry matter intake and milk production and composition. This study have been conducted in commercial dairy farms at different environmental conditions. It could be concluded that the interaction between nutrition and environment is very important effective factor on dry matter intake and digestibility. And also on animal production (milk yield, fat corrected milk, energy corrected milk, peak of milk and milk constituents) performance.

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تأثير التغذية ومؤشر الحرارة- الرطوبة علي أداء الأبقار الهولشتين الحلابة

محمد السعيد لاشين، محمود أحمد صفوت و سامي عبد العزيز السعداوي
قسم الأنتاج الحيواني – كلية الزراعة ؛ جامعة الأزهر بالقاهرة

استخدمت تسعمائة من أبقار الهولشتين في ثلاثة مواقع (٣٠٠ بقرة في كل موقع) لدراسة تأثير ظروف مختلفة في التغذية و مؤشردرجة الحرارة والرطوبة على الأداء الأنتاجي للأبقار الحلابة (إنتاج ومكونات اللبن، معاملات الهضم، الأجترار ودرجة حموضة الكرش). استخدمت ثلاث علائق في التجربة بمعدل عليقة لكل موقع.نقوم باستعراض الظروف الغذائية و البيئية في مشاريع الألبان في ثلاثة بلدان في الشرق الأوسط، وتقديم توصيف لنظم التغذية في هذه البلدان، وتركز الدراسة على ثلاث دول السودان موقع ١، لبنان موقع٢ و الكويت موقع٣. وأشارت النتائج إلى أن زيادة كمية المأكول من الألياف المؤثرة الذائبة في الوسط المتعادل (peNDF) أدت الي زيادة عملية الأجترار والمحافظة علي ثبات واستقرار الرقم الهيدروجيني للكرش، ولكن ذالك لم يؤثر على كمية المأكول من المادة الجافة أو الألياف الذائبة في الوسط المتعادل.حجم جزيئات العليقة معبرا عنها بالألياف المؤثرة الذائبة في الوسط المتعادل هو مؤشر عملي لتقدير عملية الأجترارفي الأبقار الحلابة في مشاريع انتاج الألبان. زيادة نسبة البروتين الخام والكربوهيدرات غير الليفية في العليقة أدي الي زيادة معاملات الهضم لكل من المادة الجافة والبروتين والدهون والألياف الذائبة في الوسط المتعادل ، في حين انخفضت معاملات الهضم لكل من المادة العضوية والكربوهيدرات غير الليفية و الألياف الذائبة في الوسط الحامضي. إنتاج ومكونات اللبن تأثرت سلبا بارتفاع مؤشردرجة الحرارة – الرطوبة (THI) ؛ كلما زاد من ٦٣ إلى ٧٦؛ انخفض أداء الحيوان بالأنخفاض في كمية المأكول من المادة الجافة و كمية اللبن ومكوناته . يمكن التوصية بأن التداخل بين التغذية والبيئة هو عامل هام جدا ومؤثر علي المأكول من المادة الجافة . وأيضا علي الأداء الأنتاجي للحيوان (كمية اللبن؛ اللبن المعدل للطاقة؛ اللبن المعدل للدهن؛ قمة انتاج اللبن وتركيب اللبن).