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EFFECT OF HOUSING PRACTISE ON BUFFALOE'S MILK YIELD, COMPOSITION AND SOME TECHNOLOGICAL PROPERTIES DURING COOL WINTER CONDITIONS

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SUMMARY

The effect of housing practise on milk yield, composition and some technological properties of water buffaloes was studied during winter cool conditions. Ten Egyptian water buffaloes in early lactation (8 weeks) were assigned to two groups balanced for age, days in milk and milk yield: 1 st group (G1) housed indoors during the day (air temperature (AT) at 12 - 14 h = 15.7 °C) and outdoors during the night (AT at 23-24 h = 7.3 ° C), and 2 nd group (G2) housed outdoors during the day (AT = 17.5 °C) and indoors during the night (AT= 10.5 ° C). G1-animals had lower milk yield and yield of milk protein, casein and lactose than that housed indoors during the night (G2). Also, fat protein corrected milk (FPCM) tended to be lower in G1 animals. However, milk fat percentage increased ($P< 0.07$) in milk of G1 animals. Milk chloride was higher ($P< 0.01$) in G1 animals. Acidity was similar in the two groups. There were no significant differences between the two housing practises in milk chloride/lactose ratio, phosphorus and calcium percentages.

In G1-animals, casein micelles diameter and molecular weight tended to be higher, while rennin coagulation time (RCT) and parameters of heat stability, concentration of ethanol and $CaCl_2$ test tended to be lower. It is concluded that winter cool temperature (G1-animals) decreased milk yield and milk protein and lactose yield but increased milk fat percentage.

Keywords: Buffaloes, housing practise, air temperature, milk yield, milk composition

INTRODUCTION

Low environmental temperature have negative effects on animal performance (Holmes, 1971; Milligan and Christison, 1974; Slee, 1985 and Young, 1985). Cool winter conditions in Upper Egypt are not always severe however, air temperature may reach to lower than 1 °C during the night. This temperature condition is of course not sever to the animals housed indoors during the night, but that housed outdoors in such condition may be less productive. In particular no data are available on the effect of outdoor housing during cool winter on buffaloes' milk production.

The aim of this study was to determine the specific influence of housing practise during cool winter conditions on buffaloe's milk production and some of its technological properties in Upper Egypt.

MATERIAL AND METHODS

The present study was carried out during winter season in Animal Production Experimental Farm of Animal Production Department, Faculty of Agriculture, Assiut University. Average air temperature of Assiut province, obtained from the Meteorological Department during the study, was 7.6 ± 0.3 and 11.4 ± 0.3 °C during the night and day, respectively, while the maximum and minimum relative humidity were 90.5 ±0.2 and 38.0 ±1.1, respectively. Wind speed was 5.3 ±0.5 KTS (KT= 1.25 mile/h).

Animals and their Management

Ten lactating buffaloes in early lactation were used in this study. Animals were chosen in early-lactation because the effect of cold weather is the highest during this stage as stated by Thompson (1973) and Johnson (1976). Animals were assigned to two treatment groups balanced for body weight, milk yield and weeks of lactation; 456.4 ±36.9, 456.4 ±36.0 kg; 5.28 ± 0.48, 5.18 ±0.48 kg/d and 8.0 ±1.07, 7.6 ±1.33 weeks, for groups 1 and 2, respectively. Housing practises were assigned as follows; 1 st group (G1) housed indoors during the day (air temperature (AT) at 12-14 h = 15.7 °C) and outdoors during the night (AT at 23-24 h = 7.3 °C), 2 nd group (G2) housed outdoors during the day (AT= 17.5 °C) and indoors during the night (AT= 10.5 °C). The 1 st group was exposed to lower air temperature during both the day and night than the 2 nd group. The building is a semi-closed barn which had cement floors and roofs, and side walls of cement bricks. The hight, width and length of building are 5.0, 22.5 and 37.5 m, respectively. The hight of windows base from ground is 2.25 m. Bales of rice straw were used to close the windows during winter season. The trial included two weeks as preliminary (adapting) period and three weeks as test period.

During the study all animals were fed rations consisting of 60% concentrates and 40% roughage (rice straw and berseem) to cover their requirements calculated according to Ghoneim (1967). The concentrate diet was consisted of corn (40%), cottonseed meal (25%), wheat bran (32%), limestone (2%) and sodium chloride (1%). The concentrate diet was offered twice daily just before milking and water was offered to the animals four times daily. Air temperature and relative humidity were recorded at 12-14 h and at 23-24 h during the test period (Table 1).

Table 1. Air temperature and relative humidity during the experiment.

Item	Air temperature, °C		Relative humidity, %	
	12 -14h	23-24 h	12-14 h	23-24 h
Winter, indoor	15.6±1.92	10.5±1.32	68.0±2.31	69.6±2.33
Winter, outdoor	17.5±2.18	7.3±0.88	62.6±2.91	73.0±5.13

Milk Sampling and Analytical Methods

Animals were hand milked twice daily at 7:00 h and 16:00 h, and the milk yield was recorded. Fat protein corrected milk (FPCM), was calculated as described by Schwab and Kirchgessner (1990) using the following formula:

FPCM (kg) = milk yield (kg) x (0.37 x fat % + 0.21 x protein % + 0.95) /3.1 .

Individual milk samples as well as composite samples from each evening and morning milking were taken at the end of the preliminary period and weekly during the test period. Milk fat, total protein, casein, chloride and acidity were determined as described by Ling (1963). Total calcium was measured according to Kolagena and Graltsteva (1973). Phosphorus was estimated spectrophotometerically (Kolagena and Graltsteva, 1973). Lactose content was measured according to the method of IDF (1974). The chloride/lactose ratio (Koestler Number) was calculated as follows: K. N. = (chloride %/ lactose %) x 100.

Technological Tests

The composite samples were tested for diameter (angstrom, A°) and molecular weight of casein micelles using the light scattering method of Davidov (1963). The stability of milk protein, clot on boiling test, to ethanol and Ca Cl_2 were determined according to the method of White and Davies (1958). Determination of rennin coagulation time (RCT) was carried out at 37° C using 1 % rennet solution as described by Berridge (1955).

Statistical Analysis

The effects of housing practise, test week and interaction were statistically evaluated using Harvey (1987) computer program and the following model:

$$Y_{ijk} = u + h_i + w_j + hw_{ij} + e_{ijk}$$

where u is the overall mean, h_i is the fixed effect for the i th housing practises (2), w_j is the fixed effect of the j th week of test period (3 wks.), hw_{ij} is the interaction effect and e_{ijk} is the error term of the k th item in subgroup ij.

RESULTS AND DISCUSSION

At the end of the preliminary period milk yield and milk protein, casein and lactose showed no significant differences between the two groups. However, milk fat was significantly higher (P<0.04) in group 2. Acidity of milk and chloride concentration did not differ between groups, but phosphorus and calcium concentrations were lower in group 1 (Table 2). FPCM was 7.4 and 7.5 kg/d for groups 1 and 2, respectively.

During the test period, milk yield and FPCM of G1-animals were lower than that of G2-animals (Table 3), particularly at the first week of that period, where milk yield decreased by 8 % (Fig. 1). Group 1, housed outdoors during the night, was exposed to the lowest air temperature (7.3 °C) plus windy weather (6.049 miles/h). Holmes (1971) stated that an air temperature of 10°C with an air movement of 9.6 mile/h would be equivalent to air temperature of -10 °C with an air movement of 0.6 mile/h. Cold exposure decreased milk yield is expected due to several physiological responses to cold: 1) Cold exposure or low ambient temperature decreases the secretion rate of both growth hormone (Dauncey and Buttle, 1990 and Scott and

Christopherson, 1993) and prolactin (Koprowski and Tucker, 1973 and Wetteman and Tucker, 1976), both hormones concentrations particularly GH are positively correlated with milk yield (Bines and Hart, 1978; Riss, 1983; Ludri *et al.*, 1990 and Schwab and Kirc, 1990). 2) Cold exposure or low ambient temperature decreases apparent digestibility of dry matter and organic matter (Christopherson, 1985; Kennedy *et al.*, 1986; Christopherson *et al.*, 1993) even when food intake is held constant (Christopherson *et al.*, 1993) due to the increase in reticular motility, on other words, the decrease in retention time of both particulate and fluid digesta (Christopherson and Kennedy, 1983; Hidari *et al.*, 1991). In addition, cold exposure decreases blood flow to the reticulorumen and absorption from the gut (Schaefer and young, 1980). Indeed, all of these factors limits the availability of blood nutrients for milk synthesis in cold-stressed animals. 3) Cold exposure is a cause of directing more dietary energy from milk production to increase the animal`s heat demand in the cold environment (Young, 1985). 4) Cold exposure stimulates stress hormones, adrenaline, noradrenaline and cortisol secretions (Panaretto and Vickery, 1970; Thompson *et al.*, 1978 and Samson *et al.*, 1983). These hormones may be negatively correlated with milk production, however this needs further study. 5) Cold exposure acts as a local cooling of the mammary gland which can cause a decrease in the rate of milk synthesis within the udder (Holmes, 1971), in part due to the decrease in enzymatic activity within the secretory cells and decrease of blood flow in the mammary gland due to vasoconstriction during cold exposure (Linzell, 1950) or both.

Reduced milk yield in cold-exposed lactating cows has been documented in previous studies (Holmes, 1971; Thompson, 1973; Milligan and Christison, 1974; Johnson, 1976 and Young, 1981).

Table 3 presents milk composition, and figures 2-4 show that protein, casein and lactose percentages were not significantly affected by housing practise. However, daily yield of milk protein, casein and lactose tended to be lower in cold exposed animals (G1). In this respect Holmes (1971) reported that milk protein and lactose were reduced significantly at the morning milking after 22 h cooling (equivalent to an AT -10° C) of one half of the udder.

Table 2. Milk yield and composition of water buffaloes after the two preliminary weeks period at the start of test period.

Item	Group 1	Group 2	SE	Prob.
Milk yield , kg/d	5.28	5.18	0.48	0.9
Protein, %	3.98	3.93	0.04	0.4
Protein yield, g/d	211.40	203.80	20.96	0.8
Casein, %	3.30	3.27	0.04	0.6
Casein yield, g/d	175.6	169.80	17.57	0.8
Fat, %	6.92	7.38	0.13	0.04
Fat yield, g/d	363.80	382.8	34.48	0.7
Lactose, %	4.65	4.56	0.04	0.2
Lactose yield, g/d	244.60	236.40	2.74	0.8
Chloride, mg/dl	71.00	72.00	0.001	0.30
Phosphorus, mg/dl	106.40	116.00	1.72	0.003
Calcium, mg/dl	159.40	174.60	2.61	0.003

Fig 1. Milk yield of buffaloes as affected by housing practise

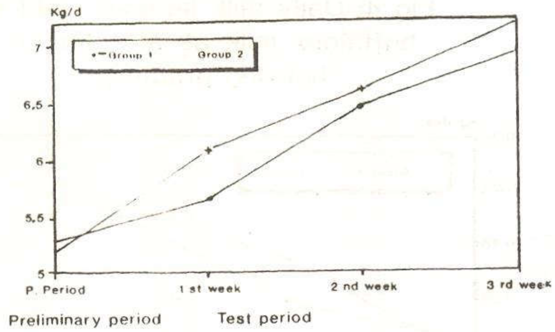

Fig 2. Daily milk protein yield in buffaloes milk as affected by housing practise.

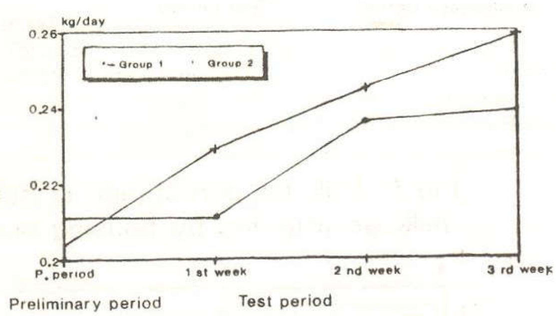

Fig 3. Milk casein yield in buffaloes milk as affected by housing practise.

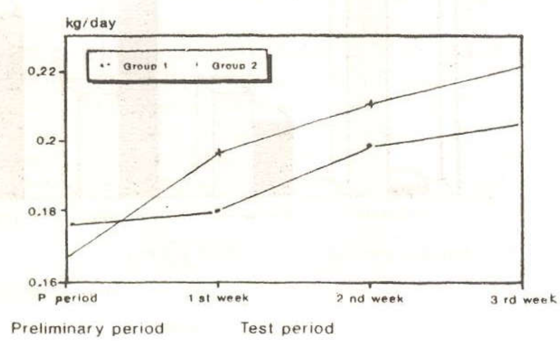

Fig 4. Daily milk lactose yield in buffaloes milk as affected by housing practise.

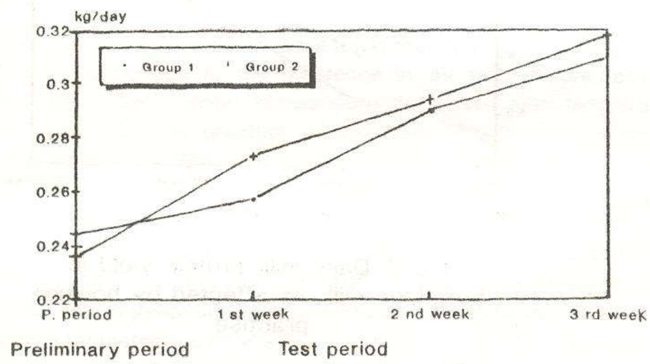

Fig 5. Milk fat percentage in buffaloes milk as affected by housing practise.

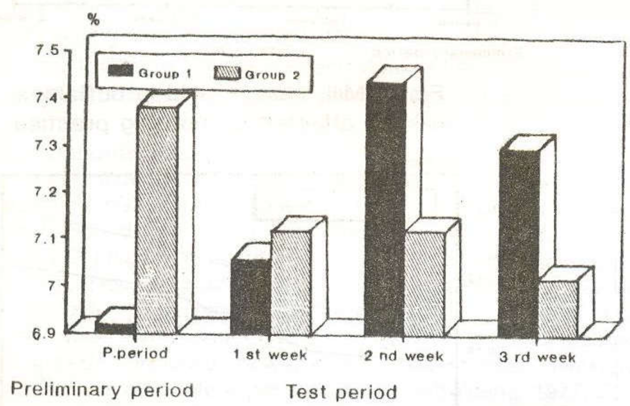

Table 3. Milk yield and composition of water buffaloes as affected by housing practise.

Item	Group1	Group2	SE
Milk yield , kg/d	6.34	6.61	0.27
Protein, %	3.61	3.69	0.05
Protein yield, g/d	228.67	244.13	11.67
Casein, %	3.06	3.15	0.04
Casein yield, g/d	194.20	208.93	10.23
Fat, %	7.27[a]	7.09[b]	0.07
Fat yield, g/d	459.00	469.00	18.62
FPCM, kg/d	7.76	8.01	0.27
Lactose, %	4.52	4.46	0.03
Lactose yield, g/d	285.53	295.07	12.12
Chloride, mg/dl	72.00[c]	70.00[d]	0.00
Cl/lactose	1.60	1.57	0.01
Phosphorus, mg/dl	112.87	111.00	0.97
Calcium, mg/dl	168.87	166.67	1.42

a,b ($P<0.07$); c,d ($P<0.01$).
- G1 housed indoors during the day and outdoors during the night,
G2 housed outdoors during the day and indoors during the night in winter.

Milk fat percentage of G1-animals was significantly higher ($P<0.07$) than that of G2-animals (Fig. 5 and Table 3). High milk fat percentage might be caused by either (1) high blood acetate, which is the major precursor of fatty acid synthesis in the mammary gland (Riss, 1983), or (2) fatty acids mobilized from adipose tissue, which act as a source of milk fat fatty acids (Baldwin and Smith, 1983). However, in view of the depression in crude fiber digestibility and acetate production in the rumen which accompanies exposure to decreased air temperature (Kennedy *et al.* 1986), a consequential reduction in milk fat is to be expected. Therefore, the fatty acids mobilized from adipose tissue due to high cortisol level during cold exposure (Panaretto and Vickery, 1970; Samson *et al.*, 1983) are presumably a cause of higher milk fat percentage. Similarly, in lactating cows, cold weather and lowered ambient temperature increased milk fat percentage and this effect was more pronounced during the early stages of lactation (Thompson, 1973; Johnson, 1976). Also, Holmes (1971) found that all milk components except fat were reduced at the afternoon milking after 9 h cooling of one half of the udder.

Chloride, Cl/lactose ratio, phosphorus and calcium concentrations tended to be higher in cold exposed animal's milk (G1) (Table 3). The higher calcium and phosphorus percentages in milk of these animals in the present experiment may be due to either a decrease in its uptake for milk synthesis/ milk yield (Table 3 and Fig. 1), or a decrease in the rate of its anabolism within the body due to high cortisol level during cold exposure. Milk acidity showed similar value in both treatment groups (Table 4). The diameter and molecular weight of casein micelles were slightly higher and negatively related to RCT and parameters of heat stability, concentration of ethanol and $CaCl_2$ test, in the cold exposed animals (Table 4).

In conclusion, during cool ambient temperature, animals housed outdoors, particularly during the night produced less milk yield, milk protein, casein and lactose yield, but more milk fat percentage, presumably due to hormonal changes during cold exposure, this a fertile area for extensive research.

Table 4. Effect of housing practise on some technological properties of buffaloes' milk.

Item	Group 1	Group 2
Acidity, %	0.167±0.002	0.166±0.002
Casein micelles		
Diameter (A°)	916.68±12.65	888.17±12.02
Molecular weight x10^6	233.06±3.77	227.11±8.70
RCT (min.)	19.96±0.89	21.03±1.02
Clot on boiling test		
Conc. of ethanol	70.67±1.33	72.00±1.00
1% $CaCl_2$, ml	68.67±1.13	70.00±1.00

REFERENCES

Baldwin,R. L. and N. E. Smith, 1983. Adaptation of metabolism to various conditions: milk production in : P. M. Riis, Ed., Dynamic biochemistry of Animal production. pp. 359-386, Elsevier Scienc Publishers. B. V., The Netherlands.

Berridge, N. J., 1955. Purification and assay of Rennin, in S. P. Colowick and N. D. Kaplan, ed. Methods in Enzymology, Vol.2, Academic Press, Inc. New York and london.

Bines, J. A. and I. C. Hart, 1978. Hormonal regulation of the partition of energy between milk and body tissue in adult cattle. Proc. Nutr. Soc., 37:281-287.

Christopherson, R. J., 1985. Management and housing of animals in cold environments, in M. K. Yousef, ed., Stress Physiology in Livestock. Vol. 2, Ungulates, pp. 175-194, CRC Press Inc., Boca Raton, Florida.

Christopherson, R. J. and P. M. Kennedy, 1983. Effect of thermal environment on digestion in ruminants. Can. J. Anim. Sci., 63:477-496.

Christopherson, R. J. ; A. D. Kennedy; J. J. R. Feddes and B. A. Young, 1993. Overcoming climatic conditions. in: J. Martin; R. J. Hudson and B. A. Young, Eds., Animal Production in Canada, pp. 173-190. Univ. of Alberta, Fac. of Extention, Edmonton, Alberta T6G 2G4, Canada.

Dauncey, M. J.; H. L. Buttle, 1990. Differences in growth hormone and prolactin secretion associated with environmental temperature and energy intake. Hormones and Metabolic Research, 22:524-527.

Davidov, R. B., 1963. Zootechnical methods in dairying, Kolos, Moscow.

Ghoneim, A., 1967. Rations of milking animals in Egypt. In Animal Nutrition (1 st Ed., in Arabic). Anglo, Cairo, Egypt.

Harvey, W. R., 1987. User`s Guide for LSMLMW Pc-1 version. Polycopie, Ohio State University.

Hidari, H. ; R. J. Christopherson and J. O. Miaron, 1991. Effect of adrenergic blocking agents on metabolic rate and digestion in cold exposed steers and on VO_2 in the portal drained viscera of sheep. Proc. 12 th symposium on energy metabolism in farm animals, 1991, Zurich.

Holmes, C. W., 1971. Local cooling of the mammary gland and milk production in the cow. J. Dairy Res., 38:3-7.

International Dairy Federation (IDF), 1974. Determination of the lactose content of milk Brussels Belgium. IDF., 28.

Johnson, H. D., 1976. The effect of weather and climate on animals. in Progress in biometerology, Div. B. Vol. 1, Part 1. Swets and Zeitlinger B.V., Amsterdam.

Kennedy, P. M.; R. J. Christopherson and L. P. Milligan, 1986. Digestive responses to cold, Section V, pp. 285-306, In: L. P. Milligan, L. W. Grovum and A. Dobson, eds., Control of Digestion and metabolism in Ruminants. Prentice Hall., Engelewood Cliffs. NJ.

Kolagena, N. N. and V. P. Graltsteva, 1973. In the book, methods of analysis milk and milk production, Kolos, Moscow.

Koprowski, J. A. and H. A. Tucker, 1973.Serum prolactin during various physiological status and its relationship to milk production in the bovine. Endocrinology, 92: 1480 - 1487.

Ling, E. R., 1963. A Text Book for Dairy Chemistry, vol. 2, 3rd Ed., Chapman and Hall Lit. London.

Linzell, J. L. , 1950. Q. JL Exp. Physiol., 35:295, (Cited by Holmes, 1971).

Ludri, R. S.; R. C. Upadhyay; M. Singh; J. R. M. Guneratne and R. P. Basson, 1990. Milk production in lactating buffaloes receiving recombinantly produced bovine somatostatin. J. Dairy Sci., 72: 2283 - 2287.

Milligan, J. D. and G. I. Christison, 1974. Effects of severe winter conditions on performance of feedlot steers. Can. J. Anim. Sci., 54:605-610.

Panaretto, B. A. and P. Vickery, 1970. The rates of plasma cortisol entry and clearance in sheep before and during their exposure to a cold wet environment. J. Endoc. 47:273-285.

Riss, P. M. 1983, Adaptation of metabolism to various conditions: Nutritional and other environmental conditions in : Dynamic Biochemistry of Animal Production, pp. 319-357, Elsever Science Publishers B. U.,The Netherlands.

Samson, D. E.; J. Slee; G. E. Thompson; J. A. Goode and A. P. F. Flint, 1983. Prolongation of gestation and changes in maternal steroid hormone concentrations during cold exposure of sheep in late pregnancy. Anim. Prod. 36:1-6.

Schaefer, A. L. and B. A. Young, 1980. Gastrointestinal blood flow distribution in cold-exposed sheep. Can. J. Anim. Sci. 60:677-681.

Schwab, W. and M. Kirchgessner, 1990. Milchleistung und Milchinhaltsstoffe bei Applikation von rekombinantem bovinem Wachstumshormon an Milchkuhe. 4. Mitteilung, Energie- und prteinstoffwechsel von kuhen bei Einsatz von rekombinantem bovinen Wachstums hormon in unterschiedlichen Laktationsstadien. J. Anim. Physiol. and Nutr. 64:261-272.

Scott, S. L. and R. J. Christopherson, 1993. The effect of cold adaptation on kinetics of insulin and growth hormone in heifers. Can. J. Anim. Sci. 73:33-47.

Slee, J., 1985. Physiological responses and adaptations of sheep. In: M. K. Yousef, ed., Stress Physiology in Livestock, Vol. 2, Ungulates, pp. 111-125. CRC Press Inc., Boca Raton, Florida.

Thompson, G. E., 1973. Review of the progress of dairy science: climatic physiology of cattle. J. Dairy Sci. 40:441.

Thompson, J. R., R. J. Christopherson, V. A. Hammond and G. A. Hills, 1978. Effects of acute cold exposure on plasma concentrations of noradrenaline and adrenaline in sheep. Can. J. Anim. Sci. 58:23-28.

Wetteman, R. P. and A. A. Tucker, 1976. The influence of low and elevated ambient temperature on serum prolactin and growth hormone in heifers. A review. Int. J. Biometeorol., 20:36-41.

White, I. C. D. and D. T. T. Davies, 1958. The relation between chemical composition of milk and the stability of caseinate complex 1. General Introduction, J. Dairy Res. 25:236.

Young, B. A., 1985. Physiological responses and adaptation of cattle, in: M. K.Yousef, ed. Stress Physiology in livestock, Vol. 2, Ungulates, pp; 101-110. RC Press Inc., Boca Raton, Florida.

Young, B.A., 1981.Cold stress as it affects animal production. J. Anim. Sci. 52:154-162.

تأثير نظم الإيواء على انتاج اللبن ومكوناته وبعض الصفات التكنولوجية خلال الشتاء فى الجاموس

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تم دراسة تأثير نظم الإيواء على انتاج اللبن ومكوناته وبعض الصفات التكنولوجية خلال الشتاء فى الجاموس. تم تقسيم عشرة من الجاموس فى المرحلة الأولى من الحليب (٨ أسبوع) الى مجموعتين متزنتين بالنسبة للعمر وأيام الحليب وانتاج اللبن : المجموعة الأولى تم ايوائها داخل الحظيرة نهارا (درجة الحرارة الساعة ١٢- ١٤ = ١٥,٧ °م) وخارج الحظيرة ليلا (درجة الحرارة الساعة ٢٣-٢٤=٧,٣ °م)، المجموعة الثانية تم ايوائها خارج الحظيرة نهارا (درجة الحرارة = ١٧,٥ °م) وداخل الحظيرة ليلاً (درجة الحرارة = ١٠,٥ °م). انخفض انتاج اللبن وانتاج بروتين ، كازين ولاكتوز اللبن فى المجموعة الأولى مقارنة بالثانية. اللبن المعدل للدهن والبروتين يميل الى الانخفاض فى المجموعة الأولى ومع ذلك ارتفعت (P< 0.07) نسبة الدهن فى لبن المجموعة الأولى. ارتفع (P< 0.01) محتوى الكلوريد فى اللبن فى المجموعة الأولى. كانت نسبة الحموضة متشابهة فى المجموعتين. ليس هناك فروق معنوية بين المجموعتين فى نسبة الكلوريد الى اللاكتوز ونسبة الفوسفور والكالسيوم. القطر والوزن الجزيئى لحبيبات الكازين يميل الى الزيادة فى المجموعة الأولى ، فى حين فترة التجبن بالرنين والثبات الحرارى بالكحول وكلوريد الكالسيوم كان يميل الى الانخفاض.

الخلاصة : درجة حرارة الشتاء الباردة تؤدى الى انخفاض انتاج اللبن وانتاج بروتين ولاكتوز اللبن ولكن تزيد من نسبة الدهن.