Research Article

Seasonal effects on Growth, Physiology, Hematology and Biochemical Profiles of Naeemi Sheep Breed

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Abstract | Improving farm animal performance resilience may help alleviate harsh weather and seasonal fluctuations while also maintaining the long-term viability of livestock farming as future climate challenges become more apparent. We generate new seasonal resilience phenotypes in this study, which indicate production performance and metabolic changes in response to changing weather. We examine the impact of calendar season (summer and winter) on animal performance resilience by assessing various parameters of ewes, lambs, pregnant, male, and lactating Naeemi breed animals from the Agriculture Research Station; Kuwait Institute for Scientific Research, Kabd. The evaluation of biochemical and hematological parameters over time revealed a probable environmental effect on animal health. According to the findings, all of the hematological and biochemical indicators are within normal limits. The hematological data revealed that WBCs and RBCs vary by type and season (WBCs: 7.1–9.9 (x10^3/µl), and 5.2–7.9 (x10^3/µl); and RBCs: 8.7–11.6 (x10^6/µl), and 10–10.8 (x10^6/µl), respectively). The MCH values (11.7–12.9 pg) are above the normal range, which is linked to two other factors: mean corpuscular volume (MCV) and mean corpuscular hemoglobin concentration (MCHC) are both above the usual ranges of 25.6–31.8 fL and 14.8–45.9 g/dl, respectively. During the winter, dry ewes' total protein and hemoglobin levels are significantly greater ($P<0.05$) than other types of sheep, according to a biochemical investigation. The results showed that the physiological, biochemical, hematology analysis and production performance of Naeemi sheep were affected by the seasons and stage of production and growth.

Keywords | Naeemi sheep, Seasonal effect, Intensive management, Reproductive performance, Baseline data.

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INTRODUCTION

Climate change is having an impact all across the world, with effects such as variations in annual wet and dry patterns, intense rainfall, frost, extended heat cycles, prolonged drought, and so on (Wiebe et al., 2015; Taskinsoy, 2019; Serrano et al., 2021). These acts have consistently been proved to have a negative influence on the quality and safety of the food supply chain. Climate influences are one of the most well studied and tracked aspects that lead to food chain pollution. Climate change's impact on seasonal variability, such as the frequency of extreme weather events and shifting conditions, raises worries for livestock species' performance and productivity. Because of changes in daylight length, air temperature, and precipitation, seasonality has an impact on several physiological mechanisms in small ruminants (sheep and goats) (Tsartsianidou et al., 2021). Temperature variations throughout the year are regarded as physiological stressors that influence the biological systems of animals (Rashamol et al., 2020). These stressors have been shown to have a considerable impact on the blood haematological properties of farm animals (Barsila et al., 2020). The values of Pack Cell Volume (PCV), Haemoglobin Concentration (Hb), Leucocyte Counts (WBC), and Total Protein (TP) are crucial for determining the animal's normal physiological status, as well as for evaluating management practices, nutrition, and health issue diagnostics.

Blood biochemical and hematological characteristics are used to monitor and evaluate ruminant animals' health, nutritional, and physiological state (Samaddar et al., 2021; Păduraríu et al., 2021; Sani et al., 2021; Carta et al., 2022). These tests are commonly used to diagnose significant diseases in animals, which can result in financial losses due to diminished growth, productivity, immunity, fur, wool, and milk production (Neethirajan, 2020; Ibeagha-Awemu and Yu, 2021; Hu et al., 2020). Blood constituent analysis has also been frequently utilized to measure the efficacy of feed nutrient content and supplements and to investigate transportation stress (Liu et al., 2018; Swanson et al., 2020; Seifalinasab et al., 2022).The immune state of animals can be assessed using biochemical and hematological profiles (Loi et al., 2021). During their pregnancy, these profiles might be modified (Ardalić et al., 2019). Seasonal changes have an impact on these profiles as well (Okyere et al., 2018). Age, sex, genetics, management, housing, and climatic conditions, in addition to nutrition, stress, and reproductive status, were recognized to have a significant impact on hematological and biochemical profiles (Nawab et al., 2018; Baenyi et al., 2020). Hematological and biochemical factors differed greatly amongst small animal breeds (Mohammed et al., 2016; Tambuwal et al., 2002; Delwatta et al., 2018). Individual evidence for a variety of illnesses, such as management, nutrition, and infections, can be obtained by comparing an individual's hematological and biochemical data to the reference interval, as detailed in clinical pathology references (Fernandes et al., 2002).

Blood is a vital and dependable tool for determining an individual animal's health status (Whitham et al., 2020). The blood parameters were connected with the animal's production and reproductive efficiency (Habeeb et al., 2018), and these values were changed by the internal and external environment (Nicolás-López et al., 2021; Sawyer and Narayan, 2019). Breed, age, sex, health state, altitude, management, feeding level, hematological techniques employed, seasonal change, temperature, and physiological status of the animal all influence blood parameters (Oramari et al., 2014; Agbaye et al., 2021).When exposed to the extra-uterine environment in changing seasons, blood, like other tissues, may go through a process of adaptive remodeling. Small ruminant health is typically monitored and evaluated using hematological parameters (Fazio et al., 2016).

Given the aforementioned, the study's major purpose was to analyze and increase the database of indigenous Naeemi sheep for changes in physiological, biochemical, and hematological features during the summer and winter seasons. The data could help with the early detection of metabolic and production abnormalities in animals, as well as their overall health. We also wanted to investigate if there was a direct correlation between biochemical and hematological data in order to discover if the winter and summer seasons were linked.

RESULTS AND DISCUSSION

Body Measurements and Body Condition Score

Body measurements and live weights of live animals have been employed widely in both experimental work and selection methods for a variety of reasons (Ige et al., 2015; Cam et al., 2010). As a result, body measurement can be useful in defining performance in a variety of situations. During the summer and winter seasons, dry, pregnant, and lactating ewes, rams, and lambs had their bodies measured. LW (kg), BL (cm), WH (cm), CG (cm), and BCS (cm) were the body metrics considered. Table 1 shows the findings of LW, body measures, and BCS of Naeemi sheep at various stages of production and growth over the winter and summer. The study's findings revealed that the Naeemi flock's LW, BSC, and body measurements were all within the typical range for the breed in Kuwait (Mohammed et al., 2016). The balanced ration, which included 12 percent CP for adult ewes and rams and 16 percent CP for lambs, helped keep their BCS within an acceptable range (3.0 to 3.5) (Ahmed). The increase in temperature during the summer season lowered the ewe's appetite while also increasing the demand for milk from suckling lambs. The low BCS (2.71) of lactating ewes during the summer season could be due to this.

Dry ewe, lambs, pregnant, male, and nursing Naeemi sheep had mean live weights and body measurements (BL, WH, and CG) of 48.7, 46.3, 64.3, 54.7, and 52.1 kg, respectively. Because of the age and sex differences, the different types of animals differed considerably ($P<0.05$). Dry ewes and pregnant ewes were substantially different ($P<0.05$) in summer and winter, according to live weight data. Naeemi's live weight (52.6 kg) was much higher in the winter than it was in the summer (44.8 kg). In the winter and summer, the difference in all body measurements was 16 percent. This suggested that Naeemi sheep consumed more feed in the winter than in the summer. The results, on the other hand, revealed that lambs' weight and body measurements grew dramatically in the winter compared to the summer. This was due to the fact that the lambs were getting older. The results showed that there was no significant difference between winter and summer among pregnant and lactating Naeemi sheep. When compared to the summer season, however, pregnant animals increased by just 8.9% in the winter. Winter increased male body weight and other metrics, although not considerably ($P>0.5$). This could be because animals feed efficiency is higher in the winter due to heat stress in the summer compared to the weather in the winter.

Several variables may contribute to a decrease in the rate of mass gain during the summer. For starters, it corresponded with the end of weaning for some lambs (McKusick et al., 2001), but in ovids, natural weaning should not affect growth (Freitas-de-Melo and Ungerfeld, 2020). Second, as the summer progresses, fodder supply may dwindle, reducing bulk gain (Tsevegemed et al., 2019). Third, as lambs grew larger, their maintenance needs may have increase, or they may have achieved asymptotic body size. Finally, decreasing growth rates corresponded to the summer rut. In the absence of adult rams, males were able to breed at 5 months of age and were observed in mating groups (Réale and Bousses, 1999).

Biochemical Parameters

The mechanisms that affect the blood level of numerous metabolites make biochemical profiles difficult to understand (Autukaite et al., 2021). Tables 2 exhibit data on biochemical parameters at various stages of Naeemi sheep production and growth during summer and winter. The findings revealed seasonal fluctuations in biochemical markers, which was to be expected. The results of this study were the first to come from sheep bred in Kuwait's intensive production system. As reported in prior investigations, the biochemical and hematological values were mainly within the physiological range for sheep.

The blood stream contains a variety of protein types. Total protein is calculated as the sum of all proteins in a typical blood chemistry profile. The most prevalent protein type, albumin, is typically measured individually. High protein levels can be caused by a variety of factors, including grain overload, peritonitis, salt toxicity, dehydration, inflammation, and malignancies and infectious illnesses. Low protein levels, on the other hand, might arise as a result of malnutrition, lead toxicity, intestinal absorption issues, blood loss, and kidney or liver disease. During the summer, total protein concentrations range from 65.70 to 71.78 g/L, but in the winter, total protein concentrations range from 67.60 to 96.11 g/L. Pregnant sheep have the highest protein levels in both seasons. This could be owing to the baby' and mother's quickly changing nutritional needs, as well as the fact that dietary protein and AA requirements alter at different stages of pregnancy. According to recent studies, protein synthesis increases by 15% in the second trimester and 25% in the third trimester in pregnant animals, but AA catabolism and urea synthesis decrease, indicating that protein is preserved during the period of high demand for AAs during pregnancy (Elango and Ball, 2016). The seasons had a substantial ($P<0.05$) impact on protein levels in all types of sheep, according to this data. Although there was no statistically significant difference in total protein and albumins between the other breeds ($P> 0.05$), Glucose is a blood sugar level measurement.

Our findings revealed that in the summer, lambs and males (3.27, 3.03) had significantly higher glucose levels ($P<0.05$) than other types of sheep, such as dry ewes, pregnant, and nursing sheep (Table 2). Glucose concentrations in sheep throughout the winter seasons, on the other hand, were not significantly different. High glucose levels are linked to stressful events and the usage of certain medicines, according to the findings (steroid administration). The fall in glucose levels, on the other hand, indicated that the animal had not been properly fed or that there was a significant bacterial infection in the bloodstream. Some sheep's serum glucose levels were greater in cold conditions and dropped in hot weather ($P<0.05$), indicating a breakdown in homeostasis (Ribeiro et al., 2018). The liver, extra hepatic tissues and hormones such as insulin, glucagon, adrenaline, cortisol, and thyroid hormones manage the stable concentration of glucose in the blood during the winter (Ribeiro et al., 2018). Chloride measurement is a negatively charged electrolyte indicator (dissolved salt). It was obvious from obtained results that during winter season males were significantly ($P<0.05$) affected. The results showed lower chloride concentrates in males. This lowering in concentration could be due to some diseases in the sheep during winter seasons. It should be mentioned that on other hand the high levels of chloride occur because of diarrhea, dehydration, fluid therapy, and acidosis (where the pH of the body is abnormally low).The decreased levels of serum chloride could be related to increased heat dissipation under heat stress, which could lead to electrolyte losses through sweat, saliva, polypnea, and urine, resulting in a drop in plasma Na^+, K^+, and Cl levels. Our findings are in agreement with literature (Ramana et al., 2013; Fadare et al., 2012; Sathisha et al., 2021).

Albumin regulates the colloidal osmotic pressure of animal blood, which is an important biological function. Albumins are also used in enzyme and peptide solutions as a stabilizing agent. A common stabilizing concentration is 0.1-0.5 percent (w/v). Albumin is frequently used as a standard in Bradford and bicinchoninic acid (BCA) experiments to determine protein quantities. In the general

Table 1: Live Weight, Body Measurements, and Body Condition Score of Naeemi Sheep during Summer and Winter.

Season Type	Body Measurement	Animal Type				
		Dry Ewes	Pregnant	Lactating	Ram	Lambs
Winter	LW (kg)	52.6 ± 14.4[b]	67.5 ± 4.4[b]	53.2 ± 2.7[b]	58.0 ± 3.9[b]	34.0 ± 7.4[a]
	BL (cm)	87.2 ± 6.0[b]	86.5 ± 1.0[b]	102.5 ± 1.9[c]	100.0 ± 3.6[c]	62.8 ± 19.0[a]
	WH (cm)	83.6 ± 3.5[b]	82.7 ± 0.5[b]	99.20 ± 0.9[c]	86.2 ± 4.6[b]	63.7 ± 2.2[a]
	CG (cm)	89.4 ± 8.5[b]	104.0 ± 1.4[c]	95.7 ± 6.8[a]	97.1 ± 2.9[bc]	91.5 ± 8.9[b]
	BCS	3.0 ± 0.6[a]	4.1 ± 0.25[b]	NA	NA	NA
Summer	LW (kg)	44.8 ± 9.3[a]	61.7 ± 10.5[b]	50.9 ± 3.9[ab]	51.5 ± 19.5[ab]	46.0 ± 2.8[a]
	BL (cm)	87.2 ± 8.4[b]	77.6 ± 4.8[b]	83.1 ± 4.1[ab]	76.2 ± 11.4[a]	65.4 ± 9.7[b]
	WH (cm)	83.7 ± 1.9[c]	78.0 ± 3.1[bc]	73.7 ± 2.3[b]	78.7 ± 10.8b[c]	62.3 ± 1.7[a]
	CG (cm)	86.1 ± 5.6[a]	95.7 ± 6.8[a]	85.9 ± 1.4[a]	92.5 ± 15.8[a]	96.5 ± 5.0[a]
	BCS	2.5 ± 0.5[a]	3.3 ± 0.4[b]	2.7 ± 0.9[a]	3.1 ± 0.9[ab]	NA
Mean	LW (kg)	48.7 ± 5.5[b]	64.6 ± 4.1[c]	52.1±1.6[b]	54.7 ± 4.5[b]	46.3 ± 0.4[a]
	BL (cm)	87.2 ± 0.0[c]	82.1 ± 6.3[b]	92.8 ±13.7[c]	88.1 ± 16.8[b]	64.1 ± 1.8[a]
	CG (cm)	83.6 ± 0.1[a]	80.3 ± 3.3[a]	87.4 ±4.1[b]	82.4 ± 5.3[a]	80.1 ± 0.9[a]
	WH (cm)	87.7 ± 2.3[b]	94.8 ± 12.9[b]	86.4±1.6[b]	94.8 ± 3.2[b]	63.0 ± 1.9[a]
	BCS	2.7 ±0.3[a]	3.7 ± 0.5[b]	2.7 ± 0.9[a]	3.1 ± 0.9[ab]	NA

LW: Live weight; BL: Body length; WH: Wither height; CG: Chest girth; BCS: Body condition score (1-5 scale); NA: Not available. Values are means ± SD

[a, b, c] Means with different superscripts for each animal types and each production performance parameters are significantly different ($P < 0.05$)

Table 2: Biochemical Parameters of Blood Serum Naeemi during Summer and Winter Seasons (Mean ± SD).

Parameter		Animal Types					
		Seasons	Dry Ewes	Lambs	Pregnant	Male	Lactating
Total Protein	Abs.	Summer	0.83 ± 0.17[b]	0.69 ± 0.1[a]	0.86 ± 0.14[b]	0.83 ± 0.16[ab]	0.68 ± 0.10[a]
	Cocen. (g/L)		68.57 ± 23.19[a]	66.4 ± 2.5[a]	71.78 ± 18.9[a]	67.92 ± 22.02[a]	65.7 ± 3.27[a]
Glucose	Abs.		0.13 ± 0.02[a]	0.18 ± 0.05[ab]	0.14 ± 0.02[a]	0.17 ± 0.05[ab]	0.19 ± 0.10[b]
	Concen (mmol/L)		1.0 ± 0.89[a]	3.27 ± 2.46[b]	1.01 ± 0.98[a]	3.03 ± 2.42[b]	2.11 ± 0.99[ab]
Chloride	Abs.		1.0 ± 0.31[ab]	0.86 ± 0.28[a]	1.06 ± 0.07[b]	1.04 ± 0.11[ab]	0.81 ± 0.11[a]
	Concen (mmol/L)		171.9 ± 55.4[b]	146.3 ± 52.0[ab]	183.88 ±12.36[b]	180.50 ± 20.98[b]	137.1 ± 20.65[a]
Albumin	Abs.		0.58 ± 0.07[a]	0.62 ±0.06[a]	0.63 ± 0.08[a]	NA	0.61 ± 0.04[a]
	Concen. (g/dl)		2.57 ± 0.6[ab]	3.25 ± 0.39[b]	2.48 ± 0.87[a]	NA	2.95 ± 0.31[ab]
Hemoglobin	Abs.		1.03 ± 0.14[a]	1.33 ± 0.32[b]	1.12 ± 0.20[ab]	NA	1.25 ± 0.23[ab]
	Concen. (g/L)		99.27 ± 38.36[a]	131.7 ± 34.17[a]	101.5 ± 28.0[a]	NA	118.3 ± 29.38[a]
Total Protein	Abs.	Winter	1.00 ± 0.09[b]	0.66 ± 0.07[a]	1.04 ± 0.07[b]	0.65 ± 0.01[a]	0.65 ± 0.03[a]
	Cocen. (g/L)		91.2 ± 12.3[b]	63.57 ± 7.73[a]	96.11 ± 9.49[b]	67.60 ± 1.99[a]	67.8 ± 6.46[a]
Glucose	Abs.		0.17 ± 0.01[a]	0.17 ± 0.03[a]	0.16 ± 0.03[a]	0.16 ± 0.02[a]	0.17 ± 0.07[a]
	Concen. (mmol/L)		2.60 ± 0.77[a]	2.63 ± 1.74[a]	2.19 ± 1.75[a]	2.50 ± 1.05[a]	1.85 ± 0.85[a]

Chloride	Abs.	1.18 ± 0.09^{d}	0.76 ± 0.21^{b}	1.02 ± 0.03^{c}	0.57 ± 0.05^{a}	0.71 ± .10^{b}
	Concen. (mmol/L)	205.8 ± 16.4^{d}	129.1 ± 37.7^{b}	176.4 ± 5.5^{c}	94.07 ± 9.21^{a}	119.8 ± 18.4^{b}
Albumin	Abs.	0.64 ± 0.05^{a}	0.61 ± 0.04^{a}	0.52 ± 0.26^{a}	0.56 ± 0.10^{a}	0.62 ± 0.05^{a}
	Concen. (g/dl)	3.15 ± 0.39^{b}	2.87 ± 0.40^{ab}	3.08 ± 0.30^{ab}	2.60 ± 0.68^{a}	3.07 ± 0.35^{ab}
Hemoglobin	Abs.	1.37 ± 0.41^{a}	1.30± 0.30^{a}	1.13 ± 0.10^{a}	1.11±0.22^{a}	1.27 ± 0.31^{a}
	Concen. (g/L)	132.6 ± 51.60^{a}	126.5 ± 41.5^{a}	105.5 ± 40.4^{a}	100.34± 27.49^{a}	120.7 ± 39.4^{a}

Abs.: Absorption value; Conc.: Concentration Value; SD; NA: Not Available.
Values are means ± SD
^{a,b,c} Means with different superscripts for each animal types and each biochemical parameters are significantly different (P < 0.05)

Table 3: Hematology Profiles of Naeemi Sheep during Summer Season (Mean ± SD).

Parameters	Dry Ewes	Pregnant Ewes	Lactating Ewes	Rams	Lambs	Mean (All flock)	Reference Value*
WBC (x10^{3}/µL)	5.9 ± 0.7^{a}	6.5 ± 2.1^{a}	6.0 ± 3.4^{a}	7.9 ± 2.6^{a}	5.2 ± 1.1^{a}	6.30±1.00	4.0-13.0
LY (%)	40.00 ± 0.1^{b}	40.00 ± 0.08^{b}	40.00 ± 0.1^{b}	53.00 ± 0.07^{a}	35.00 ± 0.04^{b}	41.0 ± 0.06	50-70
MI (%)**	0.5 ± 0.0^{a}	0.49 ± 0.02^{a}	0.5 ± 0.0^{a}	0.47 ± 0.9^{a}	0.5 ± 0.0^{a}	0.49 ± 0.01	0-8
GR (%)	58.1 ± 6.5^{a}	59.2 ± 8.5^{a}	56.1 ± 8.7^{a}	45.9 ± 7.3^{b}	64.4 ± 4.4^{a}	56.74 ± 6.90	-
RBC (x10^{6}/µL)	10.6 ± 1.0^{a}	10.4 ± 1.01^{a}	10.8 ± 1.4^{a}	10.0 ± 1.29^{a}	10.6 ± 0.89^{a}	10.48±0.30	8.00-18.00
Hb (g/L)	12.2 ± 15.8^{a}	12.88 ± 10.1^{a}	14.22 ± 33.3^{a}	12.25± 13.1^{a}	12.30 ± 13.7^{a}	12.77±8.55	8.00-12.00
HCT (%)	31.0 ± 0.02^{a}	30.0 ± 0.02^{a}	31.2 ± 0.04^{a}	29.0 ± 0.03^{a}	30.1 ± 0.01^{a}	30.0±0.00	22.00-38.00
MCV(fL)	29.0 ± 2.4^{a}	29.1 ± 2.7^{a}	28.5 ± 1.9^{a}	29.2 ± 2.3^{a}	28.4 ± 2.3^{a}	28.8±0.36	16.00-25.00
MCH (pg)	11.4 ± 0.9^{a}	12.4 ± 1.3^{a}	11.5 ± 0.6^{a}	12.3 ± 0.9^{a}	11.5 ± 0.98^{a}	11.82±0.48	5.20-8.00
MCHC (g/dl)	39.47 ± 21.7^{a}	42.61 ± 17.5^{a}	40.012 ± 18.1^{a}	42.37± 28.8^{a}	40.44 ± 28.2^{a}	41.02±14.05	30.0-36.0
RDW (%)	26.1 ± 1.7^{a}	25.2 ± 1.5^{a}	25.25 ± 1.3^{a}	24.8 ± 2.0^{b}	26.36 ± 1.3^{a}	20.84±10.20	N/A

WBC: White blood cells; LY: Lymphocytes; GR: Granulocytes; RBC: Red blood cells; Hb: Hemoglobin; HCT: Haematocrit.; MCH: Mean corpuscular hemoglobin; MCHC: Corpuscular hemoglobin concentration; RDW: Red cell distribution width; PCT: Procalcitonin.
** Average of monocyte, Eosinophil and Basophils.

Table 4: Hematology Profiles of Naeemi Sheep during Winter Season (Mean ± SD).

Parameters	Dry Ewes	Pregnant Ewes	Lactating Ewes	Rams	Lambs	Mean (All flock)	Reference Value*
WBC (x10^{3}/µL)	7.1 ± 3.4^{a}	7.8 ± 2.7^{a}	9.9 ± 2.2^{a}	9.3 ± 2.1^{a}	9.1 ± 1.7^{a}	8.6 ± 1.15	4.0-13.0
N (%)	59.1 ± 8.5^{a}	56.8 ± 10.9^{a}	54.7 ± 12.0^{a}	54.1 ± 7.7^{a}	51.1 ± 9.9^{a}	55.16±3.0	30-48
L (%)	35.8 ± 7.5^{a}	36.1 ± 11.3^{a}	41.60 ± 12.2^{a}	39.3 ± 4.7^{a}	39.4 ± 11.1^{a}	38.44±2.42	50-70
M (%)	2.9 ± 0.9^{a}	3.0 ± 1.6^{a}	2.1 ± 1.9^{a}	3.6 ± 2.2^{a}	4.8 ± 1.3^{a}	3.28±1.0	0-4
E (%)	3.6 ± 0.8^{a}	4.9 ± 2.7^{a}	4.1 ± 2.7^{a}	4.3 ± 0.8^{a}	3.5 ± 2.6^{a}	4.08±0.56	1-8
B (%)	1.0 ± 0.6^{a}	1.9 ± 2.5^{a}	1.4 ± 0.9^{a}	1.10 ± 0.7^{a}	1.2 ± 1.3^{a}	1.32±0.35	0-1
MI (%)	7.5 ± 0.7	9.8 ± 2.2	7.6 ± 1.8	9.0 ± 1.2	9.5 ± 1.7	5.68 ± 0.63	0-8
RBC (x10^{6}/µL)	10.3 ± 1.6^{a}	10.6 ± 1.9^{a}	9.7 ± 1.4^{a}	11.6 ± 1.9^{a}	8.7 ± 0.9^{a}	10.18±1.07	8.00-18.00
Hb (g/L)	12.5 ± 1.0^{a}	12.8 ± 1.7^{a}	11.5 ± 1.2^{b}	13.6 ± 2.1^{a}	11.3 ± 1.1^{a}	12.34±0.95	8.00-12.00
HCT (%)	29.4 ± 1.4^{a}	29.2 ± 2.4^{a}	26.7 ±1.6^{b}	29.6 ± 3.2^{a}	27.7 ± 1.8^{b}	28.52±1.26	22.00-38.00
MCV(fL)	29.2 ± 3.1^{a}	27.9 ± 3.1^{a}	27.2 ± 2.3^{b}	25.6 ± 2.1^{c}	31.8 ± 2.7^{a}	28.34±2.32	16.00-25.00
MCH (pg)	12.4 ± 0.7^{a}	12.1 ± 0.6^{b}	11.8 ± 0.5^{b}	11.7 ± 0.5^{b}	12.9 ± 1.0^{a}	12.18±0.48	5.20-8.00
MCHC (g/dl)	42.7 ± 1.8^{a}	34.7 ± 2.8^{a}	43.0 ± 2.2^{a}	45.9 ± 2.6^{a}	14.8 ± 1.1^{a}	41.57±4.80	30.0-36.0
RDW (%)	24.3 ± 3.8^{b}	26.3 ± 4.6^{a}	25.7 ± 3.5^{b}	29.3 ± 4.9^{a}	30.1 ± 3.5^{a}	27.14±2.46	N/A

PCT(ng/m)	228.1 ±149.2[a]	360.7 ± 275.1[a]	275.5 ± 111.9[a]	504.2 ± 288.7[a]	683.4 ± 402.2[a]	410.38±185.2	N/A

WBC: White blood cells; N: Neutrophils; L: Lymphocytes; M: Monocytes, E: Eosinophil, B: Basophils; RBC: Red blood cells, Hb: Hemoglobin; HCT: Haematocrit; MCH: Mean corpuscular hemoglobin; MCHC: Corpuscular hemoglobin concentration; RDW: Red cell distribution width; PCT: Procalcitonin.

[a,b] Means with different superscripts for each animal types and hematology parameters are significantly different ($P< 0.05$). *According to Feldman et al. (2002), from Schalm's Veterinary Hematology. Philadelphia. Baltimore, New York, London, Buenos Aires, Hong Kong, Sidney, Tokyo: Lippincott Williams and Wilkins.

comparison of the breeds for total protein and albumins (P> 0.05), there was no significant difference in albumin concentrations in Naeemi during the winter and summer seasons. This showed that Naeemi sheep were well-adapted to our hard environment, and that they were able to regulate their osmotic pressure in both summer and winter.

Hematology Profile Measurements

Tables 3 and 4 illustrate the hematological parameters of different flocks as a function of season. When all flocks are averaged, hemoglobin, RBC, HCT, and lymphocytes have higher contents in the summer, while the remaining parameters have higher contents in the winter. The data in the table reveals that the Hb levels of sheep are lower in the summer than in the winter. Heat stress may cause hemoglobin molecules to precipitate in erythrocytes, resulting in lower Hb concentrations over the summer (Karthik et al., 2021). In addition, Sejian et al. (2010) found reduced Hb levels in sheep kept on a low-nutrient diet with depleted food resources (Sejian et al., 2010). The variance of exhibiting the strength of blood in terms of Hb for the sheep in different groups is significant at 90% confidence interval is the same, indicating that living under stress has no effect on the strength of the blood at this level of confidence (P>0.1). The quantity of basic structural components in the food and the body's ability to absorb these components are directly related to the amount of hemoglobin in the blood (Šimák-Líbalová et al., 2013).

The results showed that during the winter season, the range of WBCs in different types of animals ranged from 7.1 to 9.9 (x10^3/µl), whereas during the summer season, the range was 5.2 to 7.9 (x10^3/µl). Furthermore, Naeemi's WBCs were within normal limits. Age, sex, season, breed, nutrition, and lifestyle could all have a role in the results. Similarly, there are few reports on higher leucocyte counts in heat-stressed goats (Habibu et al., 2017). Individual leucocyte fractions such as neutrophils, lymphocytes, monocytes, eosinophils, and basophils were not affected by heat stress. Diverse types of white blood cells perform different roles in the inflammatory process (Šimák-Líbalová et al., 2013).

The RBC count was higher in summer rather than summer months, whereas WBC count followed an exactly opposite pattern. In the winter, our RBC findings ranged from 8.7-11.6 (x10^6/µl), while in the summer, they ranged from 10-10.8 (x10^6/µl). Stress (splenic contraction), hormonal impacts, nutrition, or adaptation to the desert environment could all be factors in the Naeemi sheep's RBC variations (Börjesson et al., 2000).

Mean corpuscular volume (MCV) and mean corpuscular hemoglobin concentration (MCHC) were linked to the MCH value (MCHC). MCH, MCV, and MCHC were all acronyms for red blood cell indices. The mean MCH (pg) values in Naeemi sheep were 12.18 (pg) in winter and 11.8 (pg) in summer, both of which were above the usual range. In addition, MCV averaged 28.3 (fL) in the winter and 28.8 (fL) in the summer. Our Naeemi sheep had mean MCHC levels of 41.5 and 41.0(g/dl) in summer and winter, respectively, which were above the usual range. These findings suggested that a high MCH value could be caused by anemia caused by a B vitamin deficiency, notably B-12. It is vital to note that the body requires these vitamins in order to produce healthy red blood cells. These types of anemia can develop if the body does not absorb B-12 effectively or if the diet is deficient in B vitamins.

However, variations in blood parameters in ewes and lambs at various stages of production, as well as during their growth in the summer and winter, could be related to heat stress and its impact on these animals' hunger. However, these were early findings, and after all of the necessary data was collected at the end of the study, a reference diagnostic database for hematological and biochemical parameters for the Naeemi breed in Kuwait's intensive production system could be constructed. The current study's hematological findings were the first reference values for Naeemi sheep in Kuwait. Because the variance of growing WBCs parameters in sheep between groups was not significant (P>0.05) to produce the same variance, sheep in different groups develop distinct health conditions.

MATERIALS AND METHODS

Animal management

For the summer and winter studies, a total of 202 apparently healthy local Naeemi ewes, rams, and lambs were used. In the LRC, KISR Research and Innovation Station, Kabd (Figure 1), Naeemi ewes, rams, and lambs were born and nurtured. All of the animals appeared to be in good health. The average live weights of Naeemi ewes and rams were 35 ± 1.5 kg and 50 ± 1.7 kg, respectively.

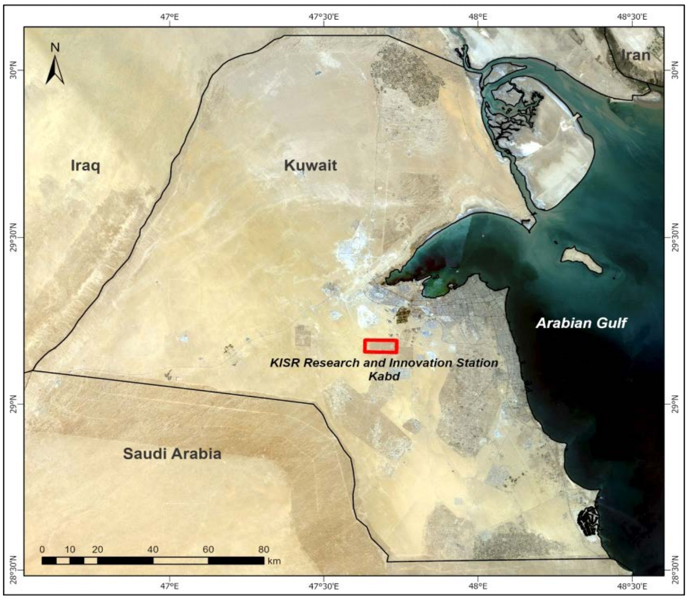

Figure 1: Location map of LRC, KISR Research and Innovation Station, Kabd

Concentrates (barley, wheat bran, corn, soyabean meal, vitamin and mineral premix, and limestone) accounted for 70% of the ration, while roughages (alfalfa hay and wheat straw) accounted for 30%. A complete ration with a concentrate (C) to roughage (R) ratio of 70C:30R was developed for mature ewes and rams. The dry matter content of crude protein (CP) and digestible energy (DE) was 13.42 percent and 12 MJ/kg, respectively. Until two weeks before joining, the rams were offered a maintenance payment, which was increased by 25%. If the ewes' body condition score (BCS) was approximately 3-3.5 cm, they were fed at the maintenance level (from 1-5 scale). During the last trimester of pregnancy, the quantity was gradually increased by 25%. Lactating ewes received 50% more feed for each individual ewe lamb, 75% more feed for twin ewe lambs, and 100% more feed for triplets or more ewe lambs. Suckling lambs were not creep fed, but they did have access to the grain that their mothers were given. The lambs were fed a complete feed of concentrate to roughage ratio of 70C:30R ad libitum after weaning. In dry matter, the CP and DE concentrations were 16.70 percent and 14.63 MJ/kg, respectively. Fresh water and mineralized salt licks were available to all animals at all times. Animals were fed two equal portions of food twice a day. The research included a series of experiments to establish baseline data on physiological, hematological, and biochemical parameters in order to assess the health and productivity of Naeemi sheep during several production seasons.

Body Condition Score

The BCS assesses the sheep's body fat reserve. BCS criteria vary from 1 to 5, and were calculated by inspecting the tail head and loin areas using Russel et al., original procedure (Russel et al., 1969). The concept behind the approach was that the lower back was the last portion of the body to gain fat and the first to shed it. The backbone and transverse processes of vertebrae in the loin region were felt to determine the BCS of sheep (Figure 2).

Figure 2: Determination of Body condition score of *Naeemi* sheep

Live Weight and Body Measurements of Naeemi Breed

During each season, biometric body measures were taken to examine the breed's growth and the properties that could alter due to environmental conditions and food factors, as well as to reflect breed standards. The animals' morphological structure and developmental ability are also revealed by their body measures. Body measurements vary depending on the breed, gender, produce type, and age of the animal. Body length (BL), wither height (WH), and chest girth (CG) are the most often used criteria for body measures in sheep (Figure 3). The BL is the distance between the anterior shoulder point and the pin bone's posterior extremity. The vertical distance between the highest point of the shoulder (wither) and the ground surface at the level of the forelegs is known as the WH. The CG is the circumference of the body measured perpendicular to the body axis and immediately posterior to the front leg and shoulder.

Hematology and biochemical analysis

Blood Sampling: Blood samples were taken in two seasons, between the hours of 6:00 and 7:00 a.m. After hair shearing and sterilization of the neck vein by a licensed veterinarian, blood samples were taken using an 18 gauge needle by jugular venipuncture and deposited in two tubes. For serum analysis, a simple tube was utilized, and for whole blood analysis, a tube containing Ethylenediaminetetraacetic acid (EDTA) was employed. Animal tag numbers, stage of production, sex, season, and date of collecting were all labeled on the tubes. Within two hours of collection, blood samples were centrifuged, and serum was extracted and kept at –20 °C for biochemical examination. All biochemical and hematological investigations were conducted in the Desert Agricultural and Ecosystem Program laboratory.

Figure 3: Body measurements of Naeem breed; BL: Body Length, WH: Wither Height, and CG: Chest Girth.

Biochemical Parameters: The concentrations of glucose, albumin, urea, chloride and total protein in the blood serum of sheep were measured using commercial kits Diasys (Diagnostic Systems GmbH, Holzheim, Germany) on the Randox RX Monza analyzer (Crumlin, United Kingdom).

Hematology Profile: Within 2 hours after collection, the Ethylenediaminetetraacetic acid (EDTA) tubes were examined. White blood cells (WBC), neutrophils (N), lymphocytes (L), monocytes (M), eosinophils (E), basophils (B), red blood cells (RBC), hemoglobin (Hb), MCH, MCHC, red cell distribution width (Kishor et al., 2020), mean platelet volume (MPV), procalcitonin (PCT), and platelet distribution width (PDW) were measured in the blood serum using the automated hematology analyzer (Cell-DYN 3700 SL) for the hematological analysis test, Abbott provided certified reference material with known blood composition. L1122, N1122, and H1122 were the three main quality control samples used in the test.

Statistical Data Analysis

Data on hematological and biochemical parameters, which were collected, were analyzed using the Statistical Analysis Software (SAS 2004). Data were subjected to a univariant analysis pipeline, and this included summary statistics, which were used to estimate distribution, measures of central tendency (such as means and median), and measures of dispersal including the standard deviation. Furthermore, confidence intervals for each estimated point were also calculated. The Bivariant correlation between two variables was measured. The analytical models were used when data was collected for hematological and biochemical parameters, which included the fixed effects of seasons, age, sex, and the production cycle of Naeemi sheep. The analysis of variance and the F test were used for comparing the means of the major effects included in the models.

CONCLUSION

Impact of seasonal variation (summer and winter) on animal performance resilience by assessing various parameters of ewes, lambs, pregnant, male, and lactating Naeemi breed were examined. From the results we can conclude that the rate of mass gain decreases in almost all the flocks. The animal health status of Naeemi sheep in different seasons was deteriorated by some biochemical and hematological parameters. Because of the drastic seasonal variations in Kuwait, the biochemical markers were fluctuated and the values were mainly within the physiological range for sheep. The hematological parameters were partially affected, when all flocks are averaged, haemoglobin, RBC, HCT, and lymphocytes have higher contents in the summer, while the remaining parameters have higher contents in the winter. These data could contribute to the knowledge of the veterinarians for monitoring the health status, diagnosis of diseases, and management of sheep breed in Kuwait.

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CONFLICT OF INTEREST

We wish to confirm that there are no known conflicts of interest associated with this publication and there has been no significant financial support for this work that could have influenced its outcome.

NOVELTY STATEMENT

In this study we describe the impact of calendar season (summer and winter) on animal performance resilience by assessing various parameters of ewes, lambs, pregnant, male, and lactating Naeemi breed. The evaluation of body measurements, biochemical and hematological parameters over time revealed a probable environmental effect on Naeemi breed health for the first time. The data could contribute to the knowledge of the veterinarians for monitoring the health status, diagnosis of diseases, and management of Naeemi sheep breed.

AUTHORS CONTRIBUTION

Faten Khalil: Conceptualization, Methodology, Writing - Original Draft Preparation, Supervision.
Harinath Yapati: Writing - Original Draft Preparation, Review, and Editing.
Ronia Jose: Methodology.
Zainab Al Blallam: Review and editing.

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