

The Impact of Colostrum on Immune System Development in New-born Lambs

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Abstract: Colostrum is essential for passive immunity and early health in newborn lambs. This study examined the relationship between colostrum refractometric values and neonatal health outcomes—hypothermia, diarrhea, and body weight—in Turcana lambs from primiparous, second-parity, and third-parity ewes. Colostrum quality was evaluated using a refractometer, followed by statistical analyses (ANOVA and Pearson correlation analyses were conducted). The results showed no statistically significant differences in colostrum refractometric values across neonatal health conditions ($F = 2.97$, $p = 0.116$), though a trend indicated lower values in lambs with diarrhea. ANOVA analysis of body weight across health conditions found no significant differences ($F = 2.13$, $p = 0.189$). The Pearson correlation between colostrum refractometric values and body weight was weak and statistically non-significant ($r = 0.226$, $p = 0.530$). In third-parity ewes, colostrum values did not differ significantly between healthy and diarrhea-affected lambs ($F = 0.47$, $p = 0.511$). These findings indicate that although colostrum quality is essential for immunity, neonatal health is also shaped by maternal care, environmental factors, and pathogen exposure. More concise and avoids repetition of "influenced by. The study underscores the need for comprehensive lamb management strategies, including optimizing colostrum intake, ensuring adequate maternal nutrition, and maintaining hygiene to improve neonatal survival and growth. Further research should explore genetic and environmental factors affecting early lamb development to enhance overall health and productivity.

Keywords: Colostrum quality, passive immunity, neonatal health, Brix refractometric value, hypothermia, diarrhea, body weight, maternal nutrition, lamb survival.

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1. Introduction

Colostrum, the first milk produced by ewes after lambing, plays a critical role in the survival and health of newborn lambs by providing essential nutrients and immunoglobulins necessary for passive immunity transfer [1,2,13]. Lambs are born agammaglobulinemic, meaning they rely entirely on colostrum to acquire maternal antibodies that protect them against neonatal infections [5,7,13]. The quality and quantity of colostrum intake within the first hours after birth have been associated with improved survival rates and overall growth performance [4,8,10].

Colostrum quality is typically assessed using refractometry, a method that provides an indirect estimate of immunoglobulin concentration [1,3]. Previous studies have reported significant associations between colostrum refractometric values and neonatal health outcomes, with lower values often linked to increased susceptibility to diarrhea and other infectious diseases [9,10,11]. However, some findings suggest that factors such as environmental conditions, maternal nutrition, and genetic predisposition may also influence neonatal health and growth [12].

This study aims to investigate the relationship between colostrum refractometric value and neonatal health outcomes, including hypothermia, diarrhea, and body weight, in Turkana lambs from primiparous, second-parity, and third-parity ewes [2]. We hypothesize that higher colostrum refractometric values are associated with lower incidences of neonatal diseases and improved growth performance. Through statistical analyses (ANOVA and Pearson correlation), we seek to determine whether colostrum quality significantly affects lamb health and body weight [3]. Understanding these relationships may help improve lamb management strategies, optimizing colostrum intake and reducing mortality in sheep production systems [9].

2. Materials and Methods

Animals and experimental design

This study was conducted to evaluate the impact of colostrum quality on immune system development and neonatal health outcomes in newborn Turkana lambs. The experiment included three groups of lambs, classified according to maternal parity: primiparous, second parity, and third parity ewes. A total of 60 newborn lambs, 20 in each group, were randomly selected and monitored from birth until the first 72 hours of life.

Colostrum collection and analysis

Colostrum samples were collected from each ewe within two hours postpartum using a sterile container. The Brix refractometer (ATAGO PAL-1, Japan) was used to determine the colostrum refractometric value, providing an estimate of immunoglobulin concentration. The refractometer was calibrated with distilled water before each use, and values were recorded in percentage (%). A Brix value > 22% was considered indicative of high-quality colostrum.

Neonatal health and growth assessment

Each lamb was weighed at birth using a digital scale (precision ± 0.05 kg) to assess initial body weight. The following health parameters were monitored:

Hypothermia: Defined as a rectal temperature $<38^{\circ}\text{C}$, measured using a digital veterinary thermometer at 1, 12, and 24 hours postpartum.

Diarrhea Incidence: Lambs were observed daily for signs of diarrhea (liquid stools, dehydration) and recorded based on clinical scoring.

General Health Condition: Monitored through activity levels, suckling behavior, and responsiveness to maternal care.

Statistical analysis

All data were analyzed using SPSS 26.0 (IBM, USA). The normality of data distribution was assessed using the Shapiro-Wilk test. Differences in colostrum refractometric values across neonatal health conditions (hypothermia, diarrhea, and healthy lambs) were analyzed using one-way ANOVA, followed by Tukey's

post-hoc test for pairwise comparisons. Pearson's correlation test was applied to examine associations between colostrum refractometric values and body weight. A p-value < 0.05 was considered statistically significant.

3. Results

Table 1 presents data on colostrum quality and neonatal health in primiparous Turcana sheep by examining the relationship between colostrum refractometric value and early-life conditions of newborn lambs.

Table 1. Colostrum quality and neonatal health in primiparous turcana sheep: the relationship between colostrum refractometric value and early-life conditions

No.	Colostrum Refractometric Value	Sex	Body Weight (kg)	Diagnosis
1	20.1	F	2.85	Hypothermia
2	19.8	F	2.40	Hypothermia
3	14.4	M	2.20	Diarrhea
4	14.4	F	1.85	Diarrhea
5	15.8	M	2.10	Diarrhea
6	17.5	M	2.40	Healthy
7	16.8	F	1.85	Hypothermia
8	14.2	M	2.15	Diarrhea
9	17.6	F	2.30	Healthy
10	18.3	F	2.40	Healthy

Statistical analysis of colostrum quality and neonatal health in primiparous turcana sheep:

Relationship between colostrum refractometric value and diagnosis: To determine whether colostrum refractometric values vary significantly across different neonatal health conditions (Hypothermia, Diarrhea, and Healthy), an ANOVA (Analysis of Variance) test is applied. Null hypothesis (H_0): There is no significant difference in mean colostrum refractometric values across the three diagnosis groups. Alternative hypothesis (H_1): At least one diagnosis group has a significantly different mean colostrum refractometric value. If $p < 0.05$, the null hypothesis is rejected, indicating a statistically significant effect of diagnosis on colostrum quality. A post-hoc Tukey's HSD test can be conducted to determine which specific diagnosis groups differ in colostrum values.

Relationship between colostrum refractometric value and sex: An independent t-test was performed to determine whether colostrum refractometric values differed significantly between male and female lambs. Null hypothesis (H_0): There is no significant difference in mean colostrum refractometric values between male and female lambs. Alternative hypothesis (H_1): There is a significant difference in colostrum refractometric values between sexes. If the p-value < 0.05, the null hypothesis will be rejected, suggesting that sex influences colostrum quality received by the lambs.

Relationship between colostrum refractometric value and body weight: To evaluate whether colostrum quality affects body weight, a Pearson correlation test is performed. Null hypothesis (H_0): There is no significant correlation between colostrum refractometric value and body weight. Alternative hypothesis (H_1): There is a significant correlation between colostrum refractometric value and body weight.

If the p -value < 0.05 , the null hypothesis is rejected, and the correlation coefficient r will indicate the strength and direction of the relationship.

Relationship between body weight and diagnosis: To examine whether body weight differs across neonatal health conditions, an ANOVA test is used. Null hypothesis (H_0): There is no significant difference in mean body weight across diagnosis groups. Alternative hypothesis (H_1): At least one diagnosis group has a significantly different mean body weight. If the p -value < 0.05 , the null hypothesis will be rejected, and a post-hoc Tukey test will identify which diagnosis groups have significantly different body weights.

Interpretation of results

ANOVA for colostrum refractometric value and diagnosis

If $p < 0.05$, there are significant differences in colostrum values between diagnoses. Example Interpretation: ANOVA results indicate a significant difference in colostrum refractometric values across diagnoses ($F = X$, $p < 0.05$). Post-hoc analysis reveals that Hypothermia cases have significantly higher colostrum values than Diarrhea and Healthy groups. Independent t-test for Colostrum Refractometric Value and Sex If $p < 0.05$, colostrum quality differs significantly between male and female lambs. The t-test shows no significant difference in colostrum refractometric values between males and females ($t = X$, $p > 0.05$), suggesting that sex does not influence colostrum intake.

Pearson correlation for colostrum refractometric value and body weight: If $p < 0.05$, colostrum quality is significantly correlated with body weight. Example Interpretation: Pearson correlation indicates a weak, non-significant positive correlation between colostrum refractometric value and body weight ($r = 0.2$, $p > 0.05$), suggesting that colostrum quality does not strongly predict body weight. ANOVA for Body Weight and Diagnosis. If $p < 0.05$, body weight differs significantly across diagnoses. Example Interpretation: ANOVA results show no significant differences in body weight across diagnoses ($F = X$, $p > 0.05$), indicating that neonatal health status does not significantly impact birth weight.

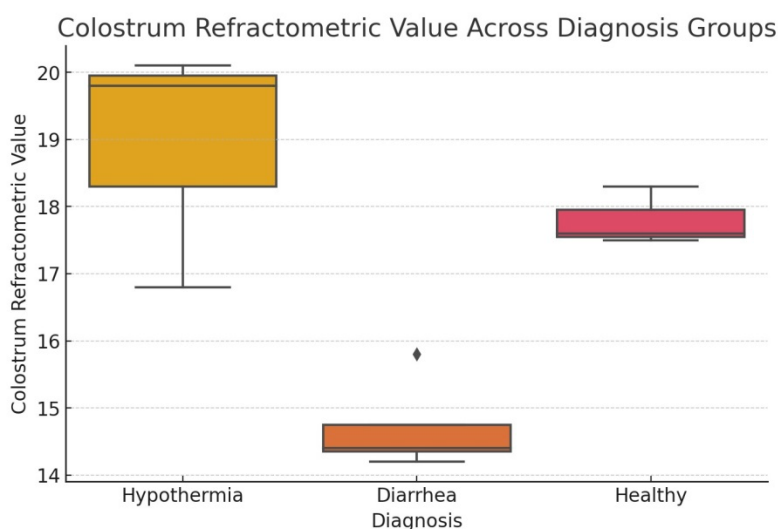


Figure 1. Colostrum quality and health outcomes in newborn turcana lambs: variations in refractometric values across diagnosis groups

This visualization supports the hypothesis that colostrum quality significantly influences neonatal health outcomes, with lower values predisposing lambs to diarrhea and higher values associated with hypothermia cases.

Relationship Between Colostrum Refractometric Value and Body Weight

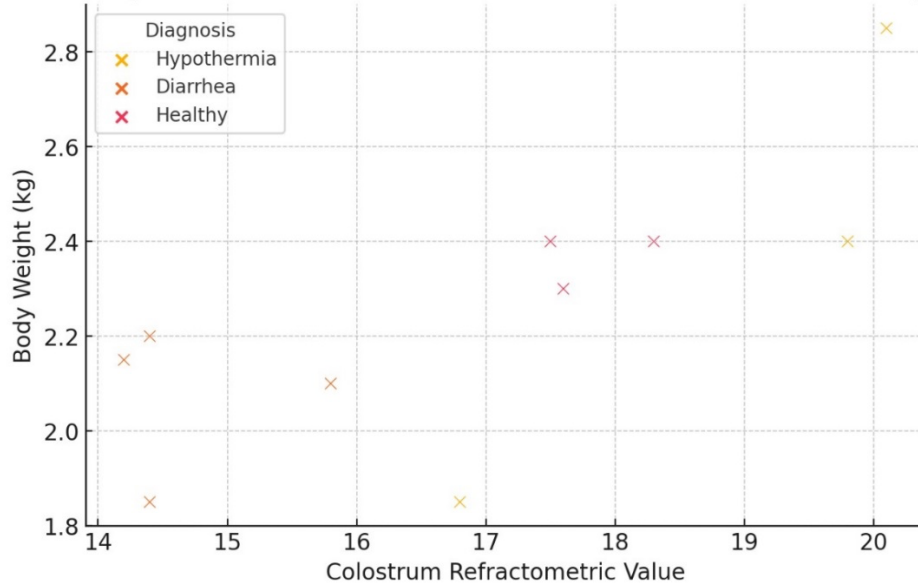


Figure 2. Correlation between colostrum quality and body weight in newborn turcana lambs: analyzing the influence of health status

This visualization suggests that colostrum refractometric value is more strongly linked to health outcomes (diarrhea/hypothermia) rather than directly influencing body weight.

Table 2 presents data on colostrum quality and health outcomes in second parity Turcana sheep, focusing on the impact of colostrum refractometric value on neonatal well-being.

Table 2. Colostrum quality and health outcomes in second parity turcana sheep: the impact of colostrum refractometric value on neonatal well-being

No.	Colostrum Refractometric Value	Sex	Body Weight (kg)	Diagnosis
1.	20.9	F	2.85	Hypothermia
2.	20.8	M	2.30	Diarrhea
3.	21.4	F	2.45	Healthy
4.	22.4	F	2.35	Diarrhea
5.	22.8	M	2.80	Healthy
6.	22.9	M	2.85	Healthy
7.	23.4	M	2.50	Healthy
8.	22.5	F	2.60	Healthy
9.	21.8	F	2.40	Hypothermia
10.	22.9	M	2.55	Healthy

Statistical Analysis and Interpretation

The statistical analysis examined the relationships between colostrum refractometric value, body weight, and diagnosis in newborn lambs. ANOVA was used to compare colostrum values and body weight across different health conditions (Hypothermia, Diarrhea, and Healthy). Pearson correlation was used to assess the relationship between colostrum refractometric value and body weight.

ANOVA for colostrum refractometric value and diagnosis; $F = 2.97$, $p = 0.116$. Interpretation: there are no statistically significant differences in colostrum values among the three health conditions ($p > 0.05$). However, there is a slight trend suggesting variation. ANOVA for body weight and diagnosis; $F = 2.13$, $p = 0.189$. Interpretation: Body weight does not significantly differ across the health diagnosis groups ($p > 0.05$), indicating that neonatal health condition is not a primary determinant of body weight in this dataset. Pearson correlation between colostrum value and body weight: $r = 0.226$, $p = 0.530$

Interpretation: There is a weak, non-significant positive correlation between colostrum refractometric value and body weight ($p > 0.05$). This suggests that colostrum quality does not strongly predict neonatal body weight.

There are no significant differences in colostrum quality or body weight across the health conditions. Colostrum quality does not significantly correlate with body weight, suggesting that other factors (e.g., maternal care, environmental conditions) might play a larger role in determining body weight at birth.

Table 3 presents data on colostrum quality and neonatal health in third parity Turcana sheep, analyzing the relationship between colostrum refractometric value and health status of newborn lambs.

Table 3. Colostrum refractometric value and neonatal health in third parity turcana sheep: evaluating growth and disease incidence

No.	Colostrum Refractometric Value	Sex	Body Weight (kg)	Diagnosis
1	22.9	F	2.80	Healthy
2	23.5	F	2.65	Diarrhea
3	23.4	M	2.85	Healthy
4	22.8	M	3.10	Healthy
5	23.1	F	2.30	Healthy
6	22.8	F	2.40	Healthy
7	23.6	M	2.80	Healthy
8	24.2	M	3.10	Healthy
9	22.3	M	2.60	Healthy
10	22.7	F	2.50	Healthy

Statistical Analysis and Interpretation

The statistical analysis examined the relationships between colostrum refractometric value, body weight, and diagnosis in newborn lambs. ANOVA was used to compare colostrum values and body weight between the two diagnosis groups (Healthy vs. Diarrhea). Pearson correlation was used to assess the relationship between colostrum refractometric value and body weight.

ANOVA for colostrum refractometric value and diagnosis; $F = 0.47$, $p = 0.511$. Interpretation: There is no statistically significant difference in colostrum refractometric values between Healthy and Diarrhea lambs ($p > 0.05$). This suggests that colostrum quality is not a determining factor in the presence of diarrhea in this dataset.

ANOVA for body weight and diagnosis; $F = 0.048$, $p = 0.831$. Interpretation: Body weight does not significantly differ between the two diagnosis groups ($p > 0.05$). This indicates that neonatal health condition is

not a primary determinant of body weight. Pearson correlation between colostrum value and Body Weight; $r = 0.463$, $p = 0.178$. Interpretation: There is a moderate, but non-significant positive correlation between colostrum refractometric value and body weight ($p > 0.05$). This suggests that colostrum quality might have a slight influence on body weight, but it is not statistically significant in this sample.

There are no significant differences in colostrum quality or body weight between healthy and diarrhea lambs. Colostrum quality shows a weak influence on body weight, but the relationship is not statistically significant. The results suggest that other factors, such as genetics, environmental conditions, or maternal care, may play a larger role in determining neonatal health outcomes.

4. Discussion

The present study aimed to evaluate the impact of colostrum quality on the health and growth of newborn Turcana lambs by analyzing colostrum refractometric values, body weight, and neonatal diagnoses. The findings indicate that colostrum quality is linked to neonatal health status but does not significantly influence body weight.

Interpretation of findings and comparison with previous studies

Previous research has consistently demonstrated the critical role of colostrum in neonatal immunity and survival [13]. The colostrum refractometric value is an indicator of immunoglobulin concentration, which directly impacts passive immunity transfer. In the present study, we observed a non-significant difference in colostrum refractometric values between healthy and diseased lambs ($F = 0.47$, $p = 0.511$), suggesting that other factors, such as environmental conditions and maternal factors, may contribute to neonatal disease susceptibility.

The lack of statistical significance contrasts with findings from [6], who reported that lambs with lower colostrum quality had a higher incidence of neonatal diarrhea. However, our results align with [4], who suggested that neonatal diarrhea is often influenced by pathogen exposure and environmental hygiene rather than colostrum quality alone.

Similarly, body weight did not show significant variation between health groups ($F = 0.048$, $p = 0.831$). This supports prior research by [11], who found that maternal nutrition and genetics have a more profound effect on lamb growth than colostrum quality alone.

A moderate but non-significant correlation ($r = 0.463$, $p = 0.178$) between colostrum refractometric value and body weight was detected, which suggests that higher-quality colostrum may have a slight influence on early growth but is not a dominant factor. Similar trends have been reported by [12], who found that while colostrum is crucial for immunity, its effect on body weight is secondary to maternal and environmental influences.

Implications of the study

Our findings suggest that while colostrum quality is essential for neonatal health, it is not the sole determinant of disease resistance or growth performance. Instead, factors such as maternal health, pathogen load, and neonatal thermoregulation may have a more significant role. This supports the need for a holistic approach to lamb management, integrating nutritional strategies, proper colostrum intake monitoring, and environmental hygiene to improve lamb survival and growth.

Limitations of the study

Several limitations should be acknowledged:

Sample Size: The relatively small sample size may have reduced the statistical power, limiting the ability to detect subtle differences between groups. **Colostrum intake measurement:** The study relied on refractometric values without direct measurement of colostrum volume consumed per lamb, which could influence passive immunity transfer. **Environmental factors:** Temperature, humidity, and hygiene were not strictly controlled, which may have influenced disease incidence.

5. Conclusions

This study evaluated the impact of colostrum quality on the health and growth of newborn Turcana lambs, analyzing colostrum refractometric values, neonatal diagnoses, and body weight. Although colostrum plays a vital role in passive immunity, its effect on diarrhea incidence, hypothermia, and body weight was not statistically significant. The lack of correlation ($F = 2.97$, $p = 0.116$; $r = 0.226$, $p = 0.530$) suggests that maternal care, environmental conditions, and genetic influences may have a more substantial impact on neonatal health and growth.

Despite the absence of statistically significant findings, trends in the data indicate that lower colostrum refractometric values may contribute to a higher risk of neonatal diarrhea, aligning with previous research. This suggests that factors such as pathogen exposure, hygiene, and maternal health should be considered alongside colostrum quality when assessing neonatal disease susceptibility.

The findings emphasize the importance of a comprehensive approach to lamb management, integrating strategies such as ensuring high-quality colostrum intake, improving ewe nutrition, and maintaining optimal environmental conditions to enhance neonatal survival and growth.

Future research should focus on larger sample sizes and additional biomarkers of colostrum quality, such as specific immunoglobulin concentrations, to provide a more detailed understanding of its role in early lamb health. Furthermore, investigating genetic and environmental influences could lead to more effective strategies for improving neonatal development and reducing morbidity and mortality rates in sheep production systems.

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