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Original Research

Seasonal Variations on Test-day Milk and its Components of Syrian Buffalo (*Bubalus bubalis*)

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Abstract

This research presents the effect of seasons on test-day milk and its components in Syrian buffaloes under semi-intensive rearing. Test-day milk (grams), fat-to-protein ratio, fat%, protein%, lactose%, non-fat solids%, ash%, and density (g/cm3) were estimated by SAS (2012). The research confirmed the occurrence of significant seasonal variation for all the studied traits except for ash%. A significant positive correlation was found between test-day milk and fat%. In contrast, a significant negative correlation was found between test-day milk and its density. In addition, there was a significant positive correlation between fat-to-protein ratio and fat% and a significant negative correlation between fat-to-protein ratio and both protein% and lactose%. The study concluded that better herd management practices and balanced diets could reduce variation in milk quantities and improve quality. Buffalo breeders could improve milk composition, ensuring higher levels of protein and lactose by adjusting the fat-to-protein ratio, resulting in higher quality milk that meets the preferences and requirements of consumers.

Keywords: Buffaloes, Milk components, Seasonal variation, Test-day milk.

Introduction

Buffaloes are the second largest exporter of milk in the world, with 134 billion liters of milk produced in 2020. This is 15% of the total global milk production (Nie *et al.*, 2022). Buffaloes in Asia account for more than 95% of the global total (Borghese and Mazzi, 2005). The buffalo population in Syria is estimated at eight thousand (FAO, 2018). Breeding Syrian buffalo is crucial for families who depend on the milk and meat of animals. They serve as draft animals in wetlands, where cows cannot survive, and locals favor buffalo products despite their higher prices. Buffaloes graze throughout the year and need concentrated feeds like "silage" and "hay" in the winter. Additionally, their resilience and disease resistance make them indispensable for livestock farming in Syria (Elsayed *et al.*, 2020). To prevent mortality in Syrian buffalo calves, it is vital to provide proper care and management. It is also vital to ensure that the calf weighs more than 30 kg at birth to reduce the risk of mortality (Al-Najjar, 2022). Buffaloes adapted to live in wetlands have been used for centuries as a source of milk, plowing, and other agricultural activities, as milk production and quality change according to environmental factors, especially seasons of the year.

Numerous studies have investigated the effects of seasons on milk production and composition in Buffaloes. Determining milk production potential and composition is critical for breeders, as milk quality affects pricing. As well as nutrition, reproduction, health, and housing management practices have significant impacts on animal performance and the farm economy. Overcoming limitations in these areas is essential for implementing better dairy farming practices (Kumar *et al.*, 2020). Therefore, this study aimed to estimate the daily production of milk and its components; examine the effect of seasons on it; and estimate the correlations between them under semi-intensive conditions in Syrian buffaloes.

Material and Methods

Syrian buffalo rearing is concentrated in the Al-Ghab region of Syrian (Figure, 1). The fertile Al-Ghab Plain is located in Hama Governorate in central Syria, where the Orontes River passes, with an area of 1200 square kilometers. It is located at latitude 35 and longitude 62 and an altitude of 270 meters above sea level. It has a mild climate with four distinct seasons.

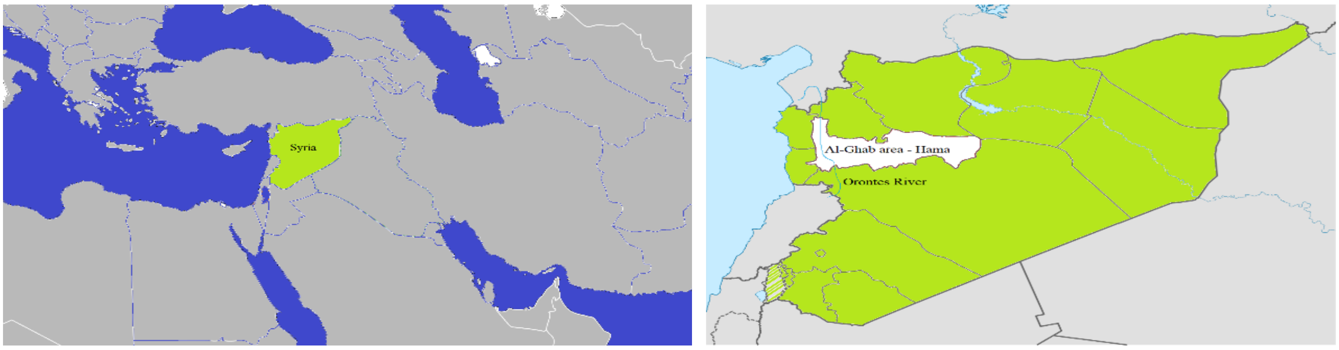

Fig 1: shows on the left side a map of Syria in the world, and on the right-side location of the Al-Ghab in Hama Governorate (Syria, 2023).

Syrian buffalo are raised to produce milk and meat to secure income for breeders. Adult buffaloes are allowed to graze from 8 am to 6 pm on natural pasture (Figure, 2) and on agricultural crop residues during the post-harvest period. During hot summer days, the buffaloes nap in a pond from 11 am to 4 pm. They are housed in concrete barns at night and during bad weather conditions in the winter season. The females are milked automatically in the morning and evening, and to ensure continuity of milk flow, concentrated feed is provided to animals during milking and newborn calves must be placed near the mother (a phenomenon of maternity).

During the milking period in 2018, monthly test day milk was recorded from 30 randomly selected buffaloes. On test day, milk was weighed using an electronic precision scale. Milk samples were taken in a volume of 200 ml twice a day immediately after milking. They were transferred to the laboratory under aseptic conditions at 4 °C. Milk samples were analyzed by Lacticheck (milk scan apparatus), and the results included fat (F%), protein (PRO%), lactose (LAC%), non-fat solids (NFS%), ash%, and milk density (g/cm^3).

Fig 2: A herd of buffalo in Al-Ghab Plain pasture, Syria.

Statistical Analysis

The data were analyzed statistically using the SAS (2012) to determine the effect of the seasons of the year on the milk of the test day and its components according to the following linear model: $\mathbf{Y_{ij} = \mu + S_i + e_{ij}}$

Where, Y_{ij} =test-day milk (grams), fat-to-protein ratio, F%, PRO%, LAC%, NFS%, ash%, and density (g/cm^3) of ij^{th} record. μ=overall mean. S_i=effect of i^{th} season of year coded as i=1, 2, 3, and 4 of Spring (March, April, and May), Summer (June, July, and August), Autumn (September, October, and November), and Winter (December, January, and February) respectively. e_{ij}=random error term associated with Y_{ij} observations with zero mean and variance $I\sigma^2$e. To discover differences between means of seasonal effects, Duncan's multiple range test (Duncan, 1955) was used. In addition, a correlation analysis was performed between the test-day milk and its contents. To estimate the association between all the studied traits, SAS (2012) employed partial correlation coefficients. That was derived from the error sums of squares and cross-product matrix (SSCP).

Results and Discussions

Table (1) shows that the highest levels of test day milk (grams), fat (%), and protein (%) were in spring, winter, and summer, respectively. However, lactose and non-fat solids (%) were lowest in the spring. Animals produce more milk during longer daylight hours in summer, which may result in more milk being available during this season. In addition, the composition of milk could vary depending on several factors, including age and diet during the season. Sarkar *et al.,* (2006) found that milk during the hot rainy season contains more milk components than in other seasons.

The fat-to-protein ratio reached its lowest level in the summer season; however, it was higher than estimates ranging between 1.1035 and 1.1058 (Hasan, 2019). The ratio of fat-to-protein increases in ketosis due to higher levels of milk fat resulting from increased levels of fatty acids in the body and their involvement in milk production. High-energy diets and lack of physical activity can lead to fat accumulation and thus increased levels of fatty acids in the body of milk animals. Conversely, the fat-to-protein ratio decreases in acidosis due to a decrease in acetic acid levels in the rumen resulting from reduced roughage intake, leading to lower milk fat levels. This provides important information about nutritional diseases such as ketosis and acidosis. The fat-to-protein ratio could be used to screen animals for subclinical ketosis and evaluate the impact of propylene glycol therapy but should not be used as a definitive diagnosis for treatment management (Nicholas *et al.,* 2015).

In terms of fat (%), Prajakta and Shailendra (2022) reported similar results i.e., higher fat (%) in winter. However, Bhonsie *et al.,* (2003) and Yadav *et al.,* (2013) found different results, with fats being higher during the hot humid summer season in India. This difference may be because summer in Syria is dry and hot, which causes animals to drink large amounts of water.

Prajakta and Shailendra (2022) and Yadav *et al.,* (2013) confirmed that seasonal variation was significant for protein (%), with the highest value observed during the humid hot season (Sikka *et al.,* 2004). Patbandha *et al.,* (2015) similarly reported a significant change in lactose (%) according to season, although Yadav *et al.,* (2013) reported a different result. Regarding NFS (%), the study result was consistent with Bhonsie *et al.,* (2003) and Prajakta and Shailendra (2022), while Bhattarai (2020) identified the opposite result. Patbandha *et al.,* (2015) reported a nonsignificant effect of season on Ash (%). In terms of milk density, Wangdi *et al.,* (2014) determined a similar value of 1.028 as the current study estimate. Differences in the results of the current study with reference studies may be due to different breeds, methods of animal care, and environmental conditions.

Table 1: Least-square means±standard errors of seasonal test-day milk and some components of Syrian buffalo milk.

Traits	Spring	Summer	Autumn	Winter	μ
TDM (gr)	5119.8±126.7[a]	3700.4±126.6[c]	3529.1±126.8[c]	4579.2±98.2[b]	4579.2±98.2
F-to-Pro ratio	1.83±0.05[a]	1.42±0.04[b]	1.74±0.05[a]	1.83±0.03[a]	1.83±0.04
F(%)	6.19±0.14[b]	5.34±0.13[c]	6.03±0.15[b]	6.61±0.11[a]	6.61±0.10
Pro(%)	3.42±0.06[c]	3.75±0.07[a]	3.53±0.06[c]	3.68±0.04[b]	3.68±0.03
Lac(%)	4.18±0.05[b]	4.65±0.06[a]	4.76±0.04[a]	4.70±0.03[a]	4.66±0.04
NFS(%)	8.57±0.09[b]	8.81±0.08[a]	8.91±0.09[a]	8.83±0.07[a]	8.83±0.07
Ash(%)	0.76±0.005	0.77±0.004	0.76±0.005	0.78±0.006	0.78±0.004
Den (g/cm³)	1.026±0.0002[b]	1.027±0.0001[a]	1.027±0.0002[a]	1.026±0.0001[b]	1.027±0.0002

[abc]...Means in the same a row without common letter are different at P<0.05; TDM=Test-day milk (gram); F-to-Pro=Fat-to-protein ratio; F(%)=Fat percentage; Pro(%)=Protein percentage; Lac(%)=Lactose percentage; NFS (%)=Non-Fat Solids percentage; Den=density×10^{-6} (g/cm³); μ=overall mean; gr=grams.

Table (2) shows that the effect of variance between seasons was highly significant in all the studied traits, except for the density of milk trait, which was only significant, while the ash(%) was not significant. This result was consistent with Sarkar *et al.,* (2006) and Veena *et al.,* (2020), who confirmed that the effect of the season is visible on test milk yield and its composition. Furthermore, seasonal variations in milk components have been reported (Ranjupt *et al.,* , 1982; Bhattarai, 2020), and seasons play a role in the overall composition of buffalo milk (Xue Han *et al.,* , 2012). On the other hand, Kekan *et al.,* (2021) reported that local buffalo breeds have a better ability to adapt to environmental conditions, which is reflected in the absence of a difference in milk components during different seasons.

Table (2): Seasonal variance analysis of test-day milk and some components of Syrian buffalo milk

Traits	MS	Errors of MS	Prob.	CV
Test-day milk (grams)	52624531.7	1445383.4	0.001	28.079
Fat-to-protein ratio	3.645	0.195	0.001	25.565
Fat(%)	30.375	1.681	0.001	21.181
Protein(%)	2.160	0.295	0.001	15.052
Lactose(%)	6.198	0.238	0.001	10.665
Non-Fat Solids(%)	1.982	0.701	0.001	9.529
Ash(%)	0.005536	0.002496	0.086	6.467
Density×10^{-6} (g/cm³)	0.000028	0.000003	0.038	0.175

MS=Mean of squares; Prob.=Probability of error type I; CV=coefficient of variation; DF=3 and 416 for season and error, respectively.

In Table (3), a positive and significant correlation was observed between test-day milk (grams) and fat (%). In contrast, test-day milk showed a negative and highly significant correlation with milk density (g/cm³). The fat-to-protein ratio displayed a highly significant correlation, positive with fat while negative with protein (%), and significant negative with ash (%). Lactose (%) exhibited a highly significant and negative correlation with both fat-to-protein ratio and fat (%) but showed a highly significant and positive correlation with milk density (g/cm³). Ash (%) displayed a highly significant and positive correlation with both protein (%) and non-fat solids (%).

Regarding previous research, Choodamani *et al.,* (2018) reported a non-significant positive correlation between protein and lactose, while ash in milk showed a positive correlation with NFS and protein, which agrees with our findings. Similarly, Gajaila *et al.,* (2014) and Choodamani *et al.,* (2018) reported a negative correlation between fat and lactose. However, Hamad *et al.,* (2014) reported a negative correlation between SNF and protein, consistent with the results of this study. In general, increasing daily milk production could increase fat percentage, but it may reduce the density of milk due to a decrease in its components. The increasing fat (%) of milk may be due to animal feeding energy-rich feed more than its needs. Excess energy is stored as fat is passed into milk produced. In general, increasing daily milk production could increase fat percentage, but it may reduce the density of milk due to a decrease in its components.

Variations in test-day milk and its composition may be due to different factors such as environment, climatic conditions, animal nutrition, and physiology. Seasonal variations in milk components are mainly due to animal feeding, as different feeds available in different seasons affect nutrient availability, which in turn affects the quantity and quality of milk. Seasons could be beneficial as a source of variation to increase milk production and maintain its quality. On the other hand, variation could be reduced through better farm management practices, as nutritional factors such as the type and quality of feed have a significant impact on milk and its components.

Table 3: Partial correlation coefficients from the error SSCP matrix Prob.>|r| of test-day milk and some components of Syrian buffalo milk

Traits	TDM (gr)	F-to-Pro (%)	F (%)	Pro (%)	Lac (%)	NFS (%)	Ash (%)
F-to-Pro (%)	0.09						
F(%)	0.12*	0.86**					
Pro(%)	0.01	-0.47**	0.02				
Lac(%)	0.02	-0.19**	-0.16**	0.09			
NFS(%)	-0.03	0.03	0.01	-0.051	0.01		
Ash(%)	-0.05	-0.10*	-0.02	0.18**	0.09	0.21**	
Den (gr/cm^3)	-0.13**	-0.06	0.06	0.06	0.26**	0.04	0.06

*SSCP=Sums of squares and cross products matrix; **=high significant; *=significant; No-sign=non-significant; D.F=416. TDM=Test-day milk (gr); F-to-Pro=Fat-to-protein ratio; F(%)=Fat percentage; Pro(%)=Protein percentage; Lac(%)=Lactose percentage; NFS(%)=Non-Fat Solids percentage; Den=density×10^{-6} (gr/cm^3); μ=overall mean; gr=grams.*

Conclusion

Seasonal variations affect the quantity and quality of test-day milk, so it is essential to emphasize good care with balanced feeding. In addition, it is necessary to apply sound management practices to ensure the best milk production from Syrian buffaloes. Due to the inverse association between protein and lactose with fat-to-protein, it is recommended to reduce the fat-to-protein ratio to a minimum whenever possible to improve milk quality.

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Contribution by Authors

Equal contribution

Conflict of Interests

There is no conflict of interest.

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