Egyptian Journal of Veterinary Sciences

https://ejvs.journals.ekb.eg/

Evaluation of Productive and Reproductive Performance of Indigenous Goats Reared Under Traditional Management Systems

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Abstract

THE research aimed to evaluate the productive and reproductive performance of local goat breeds managed under traditional systems in three tehsils of Swat: Kabal, Charbagh, and Matta. A structured questionnaire was used to collect the data on 120 goats. Further, an automatic milk analyzer was used in analyzing 20+20+20=60 (20 from each tehsil) samples of milk. There was significant variation ($P < 0.05$) between sites in both age at puberty and age at first kidding, body weight, daily milk yield, litter size and most traits of milk composition. Nevertheless, there was no significant difference in the length of the estrous cycle, milk density, and pH. Goats in Matta showed early puberty and first kidding (327.60 ± 16.77 days and 588.25 ± 27.38 days respectively) and highest daily milk production (2.05 liters) compared to that of Charbagh and Kabal (1.29 liters) and (1.09 liters), respectively. The body weights of bucks and does also differed among sites and Matta does ones were heaviest (38.68 ± 1.12 kg). Parity had a significant effect on litter size. There was a significant location to location difference in composition of milk and in particular the fat, SNF, lactose and protein contents were in the range fat 3.94=3.74; SNF, 8.45=8.15%, lactose 3.69=3.63% and protein, 3.87=4.21% respectively. In all locations, fat was inversely associated with the milk yield whereas protein had a positive correlation with it.

Keywords: Local does, Reproductive traits, Milk yield, Milk composition, Traditional management.

Introduction

Small ruminants especially goats are important to the livelihoods of the smallholder farmers especially in low-impact farming systems [1]. They have small body size, adaptability and their relatively cheap feed and management needs make them appropriate in the resource-poor communities [2]. Goats were one of the first domesticated species of livestock and their history of domestication dates as back as in the Middle East in 2500 B.C. They are now spread in a variety of ecological locations and most frequently dominate in the tropics and in drylands in the developing world [3]. Ninety-seven point three percent of total population of goats estimated to be 617 million housed in the developing countries, out of this, 65.9 percent are in Asia and 27.4 percent in Africa. They exist in Europe and Americas in percentages of 3.5 and 3.0 respectively [1, 4].

Goats have a large part to play in the economy of the rural Pakistan, especially in terms of milk, meat, skins, and income to the farmer who does not own a large landholding. Swat District in the province of

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(Received 29 August 2025, accepted 22 October 2025)
DOI: 10.21608/ejvs.2025.418629.3088

Khyber Pakhtunkhwa is a land of sheer bounty which is a large livestock producing region and is also beautiful in looks, also called as the Switzerland (Swat) of Pakistan [5]. It is geometrically located in between 34-40 to 35 N latitude and 72 to 74-6 E longitude, and rests in foothills of Hindikush mountains. Being strategically located in the region, Swat is a meeting point of South Asia, Central Asia, and China [6]. It is a population of 2.3 million people and the district is involved in rural livelihoods with livestock as a major component. Kabal, Charbagh and Matta are some of the tehsils of great importance to goat rearing. The goats have a headcount of about 382,591 in swat as per the livestock census 2017-18. There is a common rearing of breeds like Kaghani, Gaddi, Teddy and Beetal [7]. Goat rearing is an important economic process to the rural families, particularly to the poor ones [8]. It is because of the high reproduction rate of goats and their adaptation to various climatic conditions due to the large variety of species out of the range that can be used-as-forage and their nature as of fitting many climatic conditions that makes them valuable [9]. Even more conducive to their economic significance is their status as liquid assets, i.e. animals which may be sold in case of an emergency in finances. Goats have also been characterized by a high breeding rate, high kidding rate, low cost to maintain and constant demand in the market [9, 10].

The overriding focus of reproductive efficiency is profitability in goats. Attributes like age of puberty, age of first kidding, kidding interval, litter size and reproductive cyclicity are very pertinent to the flock fertility [11]. Reproduction should be well managed to ensure performance is maximized and loss to economic production is minimized [11,12]. Goats in Pakistan, though in many numbers, are lowly productive because of reason of poor feeding habits by the farmers, the traditional management system, less attention to the goats in terms of veterinary care, and absence of protection programs to improve the genetic aspect of goats [13]. This explains why they are doing less than their best towards contributing GDP to the country. Other aspects that denote socio-economic significance of goats include litter and milk production, body weight, and lactation period [1,4]. With growing awareness, the current generation of farmers is shifting away from their traditional grazing systems into more semi-intensive and intensive systems of farming to exploit the genetic potential of the local breeds to greater extent. Nonetheless, this transition is stopped by such barriers as ill-nutrition and the absence of a systematic records maintenance [14]. Technology change should be moved to better systems, with interventions organized and with regional records to guide breeding, feeding, and management decisions. Another important product and one that has a lot of nutritional as well as medical importance is that of goat milk [15]. The goat milk is non-acidic (pH 6.7) compared to cow milk (6.4), contains smaller fat globules (<1.5 u), and does not contain carotene and thus a whiter color [16]. It contains plenty of short- and medium-chain fatty acids, so it is easier digestible and it can be used by lactose-intolerant people or those with digestive problems [15]. The mentioned properties render goat milk very useful in medical dietetics and the wellbeing of children [15, 16]. To consider the increasing role of goats as a source of food security, generation of income and rural growth, the study was initiated to measure the productive and reproductive potential of local breeds of goats kept under customary management in the grazing areas/three tehsils; Kabal, Charbagh and Matta, in the District of Swat in Pakistan. The project findings will assist in the formulation of locally appropriate management tactics to enhance goat productivity.

Material and Methods

Study Area

The Department of livestock management, breeding and genetics, faculty of animal husbandry and veterinary sciences carried out the study at the University of Agriculture Peshawar, Khyber Pakhtunkhwa, Pakistan. The collection of data was done in the rural locations of district Swat where the traditional practice is to rearing goats under extensive management systems. The group of goats used was introduced to a similar environment throughout the sites whereas the care given was also similar.

Management Practices

Flocks were picked according to the population level and management consistency. In winter weather goats were covered under the old Kacha huts and during the summers they stayed open in the yards. They used to graze animals on nearby pastures every day, which were tended by women and adolescent children in the households. Grazing started early in the morning and lasted until the sunset. The balance of environmental conditions in the farms chosen was more or less equal.

Procedure of Data Collection

Three tehsils Kabal, Charbagh, and Matta were selected purposively due to their livestock density and in relevance to goats production. A formal questionnaire was developed and routine visits to farms were made in order to improve the accuracy of the information. The survey was done through a pre-tested structured questionnaire that was administered on experienced goat farmers who volunteered to respond. Important parameters measured were the size of flock, reproductive aspects and the performance of the domestic goats in relation to milk output. The traits of productivity as well as productivity were assessed according to the parameters: (In supplementary file).

Reproductive Traits

Age at Puberty (days): Number of days between birth and time of seeing the first estrus and getting a successful mating. Age at First kidding: In days, the total time between birth and the first giving birth of the doe. Length of Estrous Cycles (days): Number of days between two successive estrus cycles.

Productive Traits

Daily Milk Yield (liters): It was calculated on each of the lactating doe in the three tehsils with standard containers. A sample size of 60 milk samples was found and the milk sample of 20 lactating does were taken in three tehsils (20 samples representing three tehsils each). Udders were thoroughly cleaned and milk was taken in sterile bottles and stored in containers under ice before sampling. The composition analysis of the samples in terms of fat, protein, lactose, solids non-fat (SNF), density and pH was done by use of the automated milk analyzer at the Veterinary Research and Disease Investigation Center (VR&DIC) Swat, Pakistan.

Data Collection Survey Proforma

Standardization of data collection applied in a detailed survey proforma where the following variables were present:

Statistical Analysis

Interviews by the survey would be captured in Microsoft excel and analyzed statistically using the Statistical Analysis System (SAS) software version 6.12. The correlation coefficients were calculated to assess the relationships between productive and reproductive parameters. The statistical model involved was: Yijkl=μ+αi+βj+γk+εijklY_{ijkl} = \mu + \alpha_i + \beta_j + \gamma_k + \varepsilon_{ijkl}Yijkl=μ+αi+βj+γk+εijkl

Where: YijklY_{ijkl}Yijkl = Observed value of the dependent variable, μ\muμ = Overall population mean, αi\alpha_iαi = Fixed effect of location (i = 1, 2, 3), βj\beta_jβj = Fixed effect of feeding regime (j = 1, 2, 3). γk\gamma_kγk = Fixed effect of parity (k = 1, 2, 3). εijkl\varepsilon_{ijkl}εijkl = Random residual error

Results

The average age of puberty by goats reared in the ill-driven structures of management in the District Swat was 343.54 ± 33.27 days and first kidding 653.12 ± 55.09 days. Mean estrous was 20.10 ± 0.55 days. The average body weight of buck and doe were 51.85 ± 2.18kg and 38.15 ± 2.11kg respectively. The mean and standard error daily milk output was 1.45 ± 0.28 liters. The composition of milk had 3.87 % fat, 8.34 % SNF, 3.70 % lactose, 4.02 % proteins and 6.55 pH (Table 1).

It was found that the percentage of milk fat, SNF, lactose, and protein were significantly ($p < 0.05$) different in goats of the three tehsils Kabal, Charbagh and Matta. Kabal has also reached the highest fat value (3.94 ± 0.17%) and SNF (8.45 ± 0.23%), and Matta contained the lowest fat (3.74 ± 0.21%) and SNF (8.15 ± 0.33%). Highest protein content (4.21 ± 0.22%) was in Matta and lowest in Kabal (3.87 ±0.18%). The maximum proportion of no significant differences was found in milk density ($p = 0.0631$) and milk pH ($p = 0.0723$) among tehsils (Figure 1).

ANOVA was used to determine the impact of location, type of feed and parity on the daily milk production of the goats that were under conventional management (Table 2). Analysis of the findings indicated that the best result was three factors; location, feed type and parity have a very significant impact ($p < 0.0001$) on the daily milk yield. Among locations, highest average daily milk (2.05 L/day) was produced by goats reared in Matta followed by Charbagh (1.29 L/day) and the least milk was produced in Kabal (1.01 L/day) which is indicated in Table 3. These variations were significant effect on milk production as a result of several variables like the availability of foodstuff and weather.

Type of Feed: Goats on pure grazing had the lowest milk production (1.05 L/day) whereas the best feed that had a combination of feed and grazing had the highest production (2.01 L/day). The stall-fed goats yielded medium (1.32 L/day) (Table 3). These results indicate the significance of feeding supplements to enhance the milk output in the conventional systems.

Parity: Milk production with parity was very high as depicted in Table 3. The milk production by goats in their third parity (1.69 L/day) was significantly higher than that of the second parity (1.65 L/day) and that of first parity, which was lowest (1.17 L/day), showing that there is improvement with age and maturity in milk production up to the third parity.

Table 4 (ANOVA) and Table 5 (means and comparisons) present the impact of parity on the litter size. The outcomes showed that there was a significant difference ($p < 0.05$) between the litter size of the different parities: The second parity had the greatest litter size (2.19), and the third parity had a litter size of (2.00) and the first parity recorded the smallest litter size (1.65). When the statistical comparison was made (Table 5), it was established that the difference between first parity and second parity was too highly significant ($p < 0.01$), but the difference between second and third parity was not significant ($p = 0.15$). This implies that in the second parity, the reproductive performance gets better and stabilizes after that.

The figure 3 presents the heatmap correlation coefficients between daily milk production and milk composition traits of goats in Kabal. Daily milk production was positively correlated with protein (r =

0.35), solid non-fat (r = 0.18) and lactose (r = 0.12) but negatively with fat (r = −0.28) and density (r = −0.35) but not significantly. Lactose was observed to be significantly and positively correlated with solids non-fat (r = 0.91, p = 0.002), protein (r = 0.73, p = 0.001). Protein and solids non-fat had a negative correlation with fat. pH had positive correlations with fat (r = 0.52) and protein (r = 0.38). These results indicate that there are relationships between milk constituents, where protein and solid non-fat were not identified as positively related to milk yield.

Heatmap correlation coefficients of daily milk production and milk composition traits of goats at Charbagh shown in the Figure 4. There was a moderate positive correlation between daily milk yield and protein (r = 0.56); density (r = 0.18); however, a weak or negative relationship was found between milk yield and fat (r = −0.26), lactose (r = −0.05), and pH (r = 0.05), but all relationships were not statistically significant. Protein was deeply correlated with fat (r = 0.73), lactose (r = 0.03), and solid non-fat (r = 0.68). The association of proteins with most traits was significant. Lactose also had a positive association with solid non-fat (r = 0.72, p = 0.001). A negative correlation was observed between fat and density (r = −0.19), solid non-fat (r = −0.04). Observations tend to indicate that protein and solids non-fat are important elements that are associated with milk and other composition elements in goats from this area.

The Figure (5) presents the heatmap correlation coefficients of milk composition and daily yield traits in Matta goats. There was a positive correlation between daily milk yield and density (r = 0.27), lactose (r = 0.21), protein (r = 0.15), solid non-fat (r = 0.21), although no significant correlation was observed. Protein was also positively and significantly correlated with density (r = 0.54, p = 0.004), as well as solid non-fat (r = 0.55, p = 0.001). In a moderate correlation, lactose correlated with solid nonfat (r = 0.45, p = 0.002). Fat was also unfavorably correlated where connected to density (negative correlation: r = −0.47) and had only weak positive associations with the rest of the traits. These results indicate the overall consistent indications of protein and solids non-fat as the milk composition-related indicators in this region.

Discussion

In the current research, the average was observed as 343.54 ± 33.27 days, and it can be compared to the previous research regarding data in different goats breeds Kamohri, West African Dwarf, Siddma, Negeli, and Boriecha goats, which start puberty at 240 to 510 days [17]. Such uniformity implies that local goat breeds in Swat share analogous developmental pattern. Nevertheless, like the previous studies, this also reported a delay in puberty as compared to the previous reports of onset of puberty between 200-300 days [18]. It may be delayed by factors including nutrition and genetic variation, management practices and climatic conditions. Poor diets and conventional wide-ranging management practices in the region may be some of the contributory factors to this trend [19].

The mean age at first kidding was observed to be 653.12 ± 55.09 days. This is comparatively higher to the values reported of the other breeds like Kamohri (505 days) and Abergelle (449 days) goats [20]. This postponed by traditional grazing systems, poor plain of nutrition and ineffective breeding management. The economic significance of kidding early in age is that, it prolongs productive life of does. The fact that Swat goats mature late is an indication that measures as far as feeding and reproductive management is concerned have to be improved [17, 19].

The mean of the estrous periods estimated to be 20.10 ± 0.55 days, in accordance with the reports in Boer, Dwarf and Barbari goats, where the period was between 19.7 and 21.2 days [21]. The slight divergence with other researches may be leveled on local environmental factors like photoperiod and nutrition. The geography and climate also could be the reason behind the hormonal variations causing changes in the estrous pattern [19, 22].

Their mean body weight plus or minus standard deviation of bucks and does were 51.85 ± 2.18 and 38.15 ± 2.11 kg though it was within the range as compared to those in Negele, Boricha and other native goats based on records [23]. These outcomes affirm that the genetics of the local goats in Swat can yield once properly handled. The variation between studies in the body weight may be attributed to the differences in breeds, the ability to thrive in various environments and their diet schedule [24].

The average daily milk yield in the 3 places was 1.45 ± 0.28 liters with the greatest being in Matta (2.05 L/day). The above results are consistent with the results of Nguni and Boer goats which showed that the yields ranged between 0.65 to 1.5 L/day [23]. The difference in the milk production of the two places in the present study is explained by feeding pattern, parity and hereditary potential. Contributing to the significant increase of milk yield with the use of supplemented feeding in Matta highlights the crucial role that nutritional management ought to be utilized in the enhancement of locational performance [17, 19].

The litter size was between 1.65 and 2.19 kids; parity had a significant influence on the scale with its value being higher as parity increased. This finding is similar to the results of Arsi Bale and Central Highland goats [24]. The improvement of physiological maturity and body condition with successive parities could lead to increase ovulation rates and act as multiple birth rates [25]. The nutrition status and general health of a herd may be

improved to increase litter size and reproductive effectiveness [26].

The fat percentage was mean 3.87 ± 0.16, which is reasonable and a bit lower than those of exotic breeds but at the regular levels of indigenous goats [27]. Differences could be caused by breed differences, stage lactation and feeding plans. The results shown in this study indicate a negative relationship between fat percentage and milk yield with the relationship shown in past studies suggesting that there exists trade-off between volume and composition [28].

The solid non-fat (SNF) content of 8.34 ± 0.31 % is similar to that in local goats breed, although signs of it are reported to be less in Saanen goats [29]. It is probable that breed-ancestry and lactation stage are factors at work. Nutritional density of local goat milk which is evidenced by the strong positive correlation of SNF to protein and lactose also indicates the nutritious dietary value of the local goat milk [28,29]. The value of average milk density was found to be 26.65 ± 2.11 which is also in line with other literature [28]. The density of milk had positive correlations with lactose and SNF, which indicated the richness of output composition of the local goats milk [28].

The lactose averaged at 3.70 ± 0.19 predictably being within the range reported by other authors on different breeds [28]. It is possible that the small variation might be due to breeds and environmental cause. The correlation was a significant association between lactose content, SNF and protein content since lactose is the main carbohydrate in milk [27,29]. Protein content was 4.02 ± 0.17 which compared with crossbred goats and better than certain goats in the purebred Saanen [27]. It suggests high genetic potential of milk protein in local goats that can be used with additional benefits of selection and crossbreeding schemes [27,28]. This was the normal level of pH with a mean of 6.55 ± 0.18, which is in normal values of goat milk [28,30]. The results indicate that pH remained relatively stable across locations, suggesting a minimal environmental effect, as pH is among the least variable milk quality parameters in goats [29, 30, 31].

Conclusion

The current study revealed a good degree of deviation between the productive and reproductive measures of indigenous goats bred within the traditional management systems within the Swat district. Goats of Matta tehsil possessed desirable traits such as early puberty, first kidding, daily milk production and body weight than those of Charbagh and Kabal. Large location effect was also found on the main characteristics of milk yield, litter size, and milk composition due to differences in location and feeding aspects as well as parity. Fat, protein, SNF and lactose were observed to change significantly among the milk quality parameters, whereas density and pH were not too much varied. Ensuring better administration and food practice to increase the productivity of goats on customary approach is emphasized by these discoveries. Moreover, site-specific approaches and local treatments might maximize the hereditary potential of native goats breeds and uplift the economy of smallholders in the area.

Acknowledgments

The study supported by University of Agriculture Peshawar, Khyber Pakhtunkhwa, Pakistan.

Funding statement

The study was not received any internal or external funds.

Declaration of Conflict of Interest

The authors declare that there is no conflict of interest.

Ethical of approval

The study approved from ethical communities of the Department of Livestock Management, Breeding and Genetics, Faculty of Animal Husbandry and Veterinary Sciences, University of Agriculture Peshawar, Khyber Pakhtunkhwa, Pakistan.

TABLE 1. Over all descriptive statistic of various productive and reproductive parameters of goats reared under traditional management system in three tehsil of district Swat.

Parameters	Mean ± SE	Range	
		Minimum	Maximum
Age at puberty (days)	343.54 ± 33.27	240	500
Age at first kidding (days)	653.12 ± 55.09	400	840
Length of estrous cycle (days)	20.10 ± 0.55	18	22
Body weight of male (kg)	51.85 ± 2.18	45	60
Body weight of female (kg)	38.15 ± 2.11	30	47
Daily milk production (liters)	1.45 ± 0.28	0.50	3.00
Fat %	3.87 ± 0.16	3.1	4.5
SNF %	8.34 ± 0.31	7.2	10
Density	26.65 ± 2.11	17.70	34.10
Lactose %	3.70 ± 0.19	3.0	4.50
Protein %	4.02 ± 0.17	3.5	4.8
pH	6.55 ± 0.18	5.9	6.9

TABLE 2. Analysis of variance of Daily milk production as effected by class variable (Location, Feed and Parity)

Source	Trait	DF	SS	MS	F-Value	P-Value
Location	Daily milk production	2	3.593	1.797	14.61	0.0001
Feed	Daily milk production	2	4.824	2.412	19.62	0.0001
Parity	Daily milk production	2	2.412	1.201	10.11	0.0001

TABLE 3. Mean comparison of Daily milk production in relation to class variables (Location, Feed and Parity)

Class variables	Daily milk production(liters)
Kabal	1.01[c]
Charbagh	1.29[b]
Matta	2.05[a]
p-value	0.0001
Feed 1	1.05[c]
Feed 2	1.23[b]
Feed 3	2.01[a]
p-value	0.0001
Parity 1	1.17[c]
Parity 2	1.65[b]
Parity 3	1.69[a]
p-value	0.0001

Values within columns with different superscripts are significantly different at p<0.05.
Feed 1 = grazing animals only, Feed 2 = grazing animals + feed offered in home (tree leaves), Feed 3 = grazing animals + supplemented ration feed (concentrates, roughages (sorghum and common grass), soya bean meal and wheat bran).

TABLE 4. Analysis of variance of litter size as effected by class variable (Parity)

Source	Trait	DF	SS	MS	F-Value	P-Value
Parity	Litter size	2	3.811	1.906	2.59	0.0083

TABLE 5. Mean comparison of litter size in relation to class variables (Parity)

Class variable	Litter size
Parity 1	1.65[c]
Parity 2	2.19[a]
Parity 3	2.00[b]

Values within columns with different superscripts are significantly different at p<0.05.

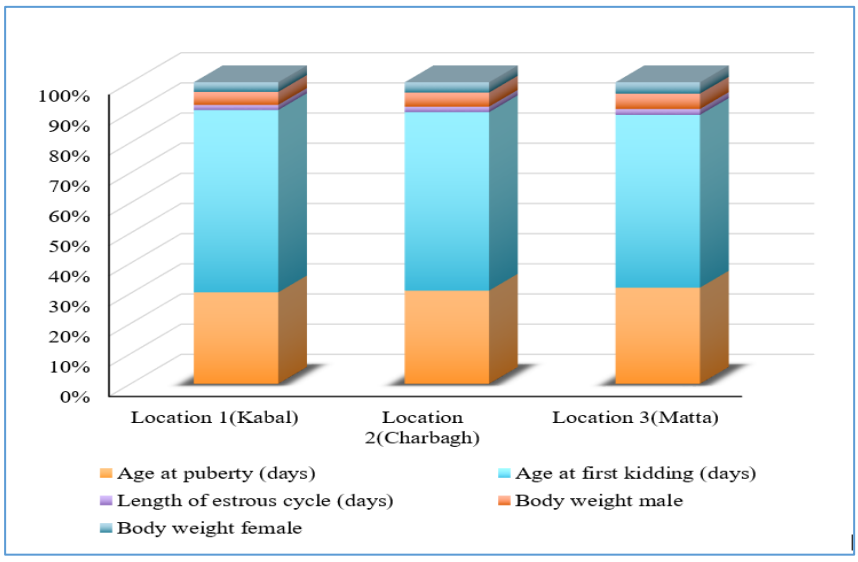

Fig. 1. Descriptive statistic of milk composition in three tehsil of district Swat.

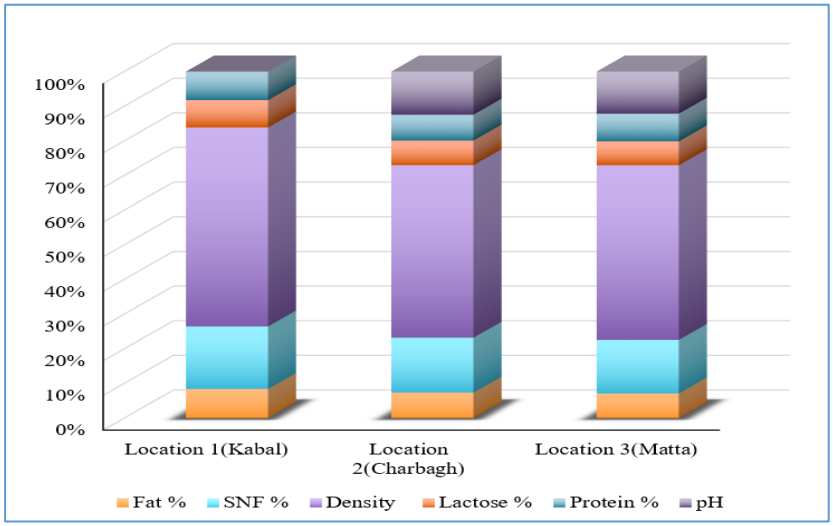

Fig. 2. Descriptive statistic of reproductive parameters in three different locations.

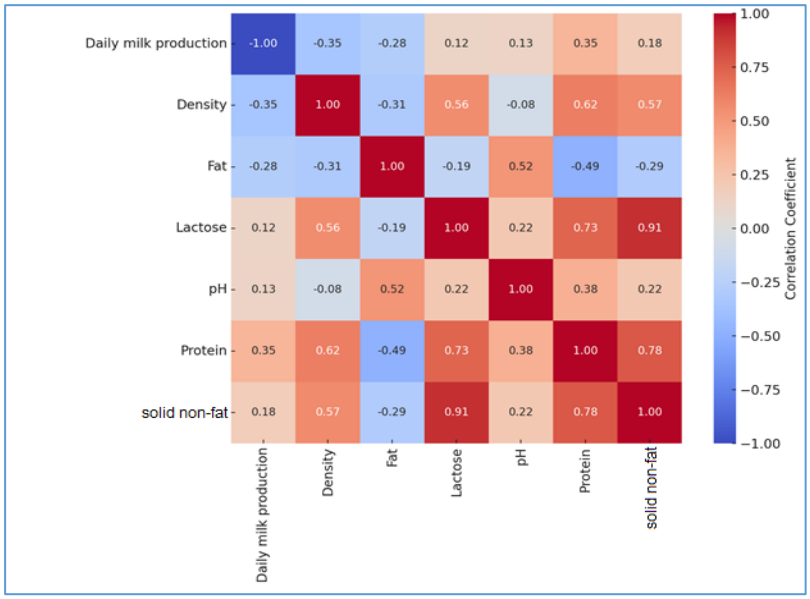

Fig. 3. Correlation heatmap of goats milk yield and composition in location 1 (Kabal)

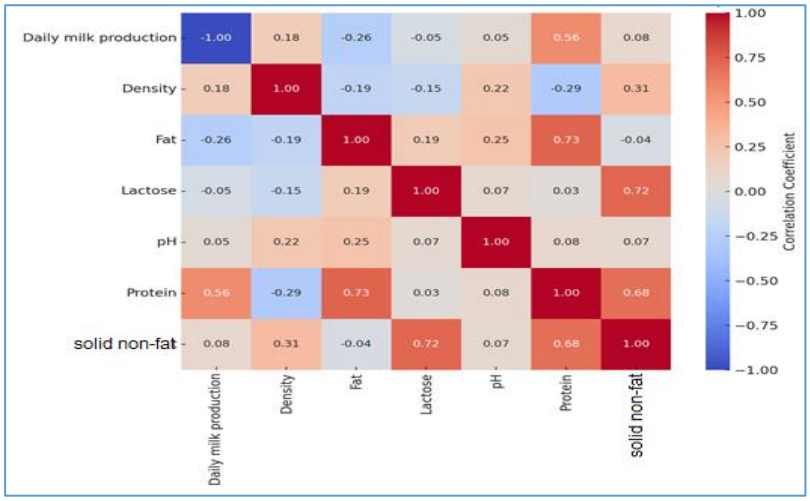

Fig.4. Correlation heatmap of goats milk yield and composition in location 2 (Charbagh)

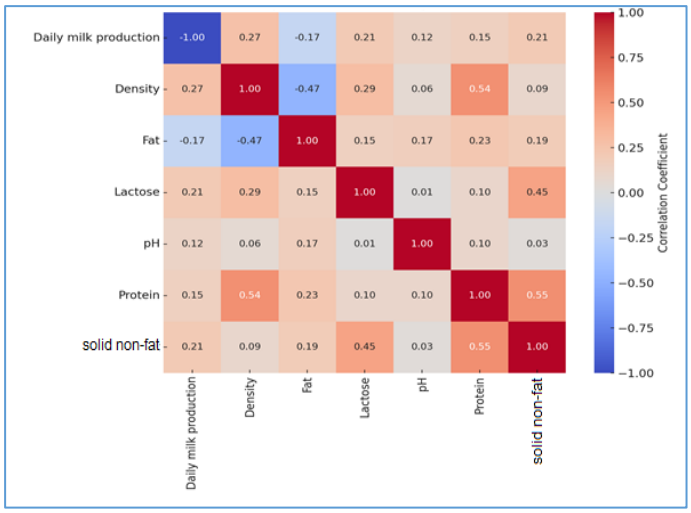

Fig. 5. Correlation heatmap of goats milk yield and composition in location 3 (Matta)

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