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Study of chemical parameters of Pantja goat (*Capra hircus*) milk under farm conditions

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Abstract
The present investigation was carried out to study the chemical parameters of Pantja goat's milk under farm conditions in the Tarai region of Uttarakhand. The average fat percent of milk increased with advancing lactation. Minimum total solids in milk were found in 1st week of morning milk (i.e. 12.42±0.314) and maximum in morning milk of the 25th week (i.e. 15.35±0.958). The highest and lowest SNF values were noted in morning milk of the 26th week and 1st week i.e. 9.77±0.124 and 8.78±0.099, respectively. The lactose content of milk in the present study also showed an increasing trend till 13 weeks after that it had decreasing trend till the 26th week. The protein content of milk was in the range of 3.97±0.219 percent to 4.3±0.158 percent whereas ash content was in the range of 0.748±0.05 to 0.86±0.017 percent.

Keywords: Pantja goats, SNF, lactose, fat, protein, goat milk, chemical property

Introduction
The importance of goat rearing in providing nutritional and financial sustenance to the economically weaker sections of society is well recognized in developing countries. There is a significant contribution of goat husbandry to the national economy also. Goat husbandry plays a significant role in livelihood and nutritional security as well as providing supplementary income to socially backward classes of the farmers. The total Goat Population in the country is 148.88 Million in 2019. About 27.8% of the total livestock is contributed by goats (Anon, 2019; 20th Livestock Census, 2019). Goat milk shares a contribution of 2.93% in total milk production across the country. Goat milk production in the country has also increased from 53.77 to 64.68 lakh tons during (2015-16 to 2021-22) (BAHS-2022) [3]. Pantja is the local goats of the Tarai region of Uttarakhand. They are recognized for their similarity with deer in their morphological characteristics. These are medium-sized goats having brown red dorsal coat color with a black back line and lighter ventral surface. There is the presence of white streaks on either side of the face (Singh *et al.*, 2010) [15]. These characteristics are permanent in nature and pass from one generation to another. As these goats are found in Tarai, they are well adapted to the climatic conditions of this region and resistant to many of the diseases of this region compared to other goats (Singh *et al.*, 2010; Vandana, 2014) [15, 17]. The composition of goat milk is almost similar compared to other mammary origins except for lipids or fatty acids profile (Turkmen, 2017) [16]. Goat milk and colostrum have recently received attention from researchers all around the world as potential replacements for cow or other milk replacers or sources of useful food ingredients (Mehra *et al.*, 2021; Prosser, 2021) [8, 13]. Numerous goat milk-based goods, including drinks, paneer, chana, ice creams, clarified butter, yogurt, and infant formula, have been produced at the industrial level and have demonstrated good sensory appeal (Bhattarai, 2014) [4]. Since ancient times goat milk has traditionally been known for its medicinal properties and has recently gained importance in human health due to its proximity to human milk for easy digestibility and its all-around health-promoting traits. The present experiment was designed to study the chemical properties of Pantja goats reared under farm conditions.

Materials and Methods
The present investigation was carried out to study the chemical parameter of the milk of Pantja goats at the Goat unit, Department of Livestock Production and Management, College of Veterinary and Animal Sciences, GBPUA &T, Pantnagar.

The experiment was carried out on a total of 20 primiparous local Pantja goats.

Milk sampling and analysis

Milk samples (About 100 ml) were collected at weekly intervals throughout the lactation period. For this teats were cleaned with 70 percent ethyl alcohol, the first 3-4 streams of milk were discarded, the samples were collected in sterilized containers and formalin solution in the proportion of 1:20,000 was used to preserve the milk samples till further analysis. The samples were subjected to various chemical parameters, *viz*. fat, protein, lactose, solid not fat (SNF), total solids, and ash content.

Chemical composition

Fat estimation

The fat percentage was determined by the Gerber method (IS: 1224, 1958). In this method, 10 ml of Gerber sulfuric acid was taken into the butyrometer. A 10.75 ml of the well-mixed sample of milk was taken with the help of a pipette and transferred into the butyrometer carefully. With the help of a tilt pipette 1 ml of amyl alcohol was added to the butyrometer. The lock stopper was put and the contents were mixed by shaking the butyrometer at 45 degrees until all the curd has been dissolved. The butyrometer was placed in the centrifuge and the machine was balanced. Centrifugation was done for 5 minutes at 1000 to 1200 r.p.m. The butyrometer was removed from the centrifuge and the fat column within the scale on the butyrometer was adjusted and read.

Protein estimation

Determination of protein in the sample of milk was performed by formal titration method (Pyne, 1932) [14]. For this 10 ml of the well-mixed milk was taken with the help of a pipette into a 100 ml flask. 5 drops of phenolphthalein indicator were added to it. Then the milk was titrated against the standard alkali to its endpoint. 2 ml of neutral formalin was added to it and mixed well. Again titrated against the standard alkali to the same endpoint as before. The volume of alkali used was recorded in the second titration.

Protein (per cent) = v × 1.7

Where,

v = Volume of N/10 Sodium hydroxide required by 10 ml of milk treated with formaldehyde

and 1.7 is Pynes constant

Lactose estimation

The lactose content in milk was determined by the colorimetric method (Oser, 1979) {11} and expressed as a percent. For this 1 ml of milk was taken into a 100 ml volumetric flask and 2 ml of 10 percent Sodium tungstate was added. 2 ml of 2/3 N Sulfuric Acid was then added and it was let stand for 5 minutes followed by dilution to the mark with water and filtration. Then 1 ml of filtrate and 1 ml of water were introduced in a Folin-Wu sugar tube. 2 ml of standard lactose solution was placed into another tube. 2 ml of the Folin-Wu alkaline copper solution was added to each tube and then heated in boiling water for 8 minutes and allowed to cool. 4 ml of acid molybdate reagent was added to each tube. After 1-minute, dilute acid molybdate solution (1:4) was added up to 25 ml mark, mixed, and the absorbance was taken with the help of a spectrophotometer at 420 nm (the instrument was calibrated at zero against water blank).

$$\text{Lactose (Per cent)} = \frac{\text{Density of Unknown}}{\text{Density of Standard}} \times 100 \times \frac{0.6}{0.01} \times \frac{1}{1000}$$

Solids not fat (SNF), total solids, and specific gravity determination

Solids not fat and total solids were determined as per the standard procedure (IS: 1183, 1957). The temperature of the colostrum/milk sample was adjusted near to 70^0F (not below 65^0F or above 75^0F). It was then gently mixed by pouring several times from one vessel to another, avoiding the incorporation of air or foam formation. A sufficient amount of colostrum/ milk was poured into the lactometer jar to allow the lactometer to float freely. The lactometer was placed in the colostrum/milk and allowed to come at a constant level. The lactometer reading and temperature of colostrum/milk were taken as soon as it assumed a constant level.

$$\text{Solid not fat (S N F)} = \frac{\text{CLR}}{4} + 0.21\ \text{F} + 0.36$$

$$\text{Total solid (T S)} = \frac{\text{CLR}}{4} + 1.21\ \text{F} + 0.36$$

$$\text{Specific Gravity} = 1 + \frac{\text{CLR}}{1000}$$

CLR is corrected lactometer reading = Observed reading to correction factor (for every degree (^{0}F) raise of temperature in milk to above 70 ^{0}F, 0.2 lactometer reading was added to the observed lactometer reading, likewise for every ^{0}F lowering of temperature of milk; 0.2 was deducted from observed lactometer reading) F is the fat content of milk which has to be ascertained by the Gerber method.

Result and Discussion

Milk Chemical Composition: The chemical composition of milk from 1 to 26 weeks is shown in Tables 1 and 2

a. Fat content

The fat percentage of morning and evening milk of Pantja goats from the first week to 26th week showed that the highest fat percentage was in the 26th week and lowest in 1st week of lactation as 4.27±0.033 and 3.43±0.093 percent, respectively. Average fat percent increased with advancing lactation. The present study is in total agreement with Hassan *et al.* (2010) [6]. They found that fat percent at 1st, 2nd, 3rd, 4^{th,} and 5th month of lactation was 3.8±0.5, 5.2±0.8, 5.4±0.9, 6.3±0.6, and 6.9±2.1 kg, respectively in Jamunapari goats. Maximum and minimum values of Pantja goat milk fat were recorded as 4.5 and 3.43 percent, respectively. The fat percentage in the milk of Pantja goats was lower than that of Jamunapari goats. The fat percentage in the milk of Pantja goats is in total agreement with reported cow and Human milk fat percentages. However, sheep milk has a higher fat percentage than the fat percent of the present finding. There was also not much difference in morning and evening milk fat percentage. The findings of Agnihotri and Rajkumar (2007) [1] are in total agreement with the present finding i.e. steady increase in the fat content throughout lactation. Nag *et al.* (2007) [10] reported 5.3±0.3percent fat in Barbari goats. It may be said that Pantja

goat milk has lower fat content than the Barbari goats.

b. Total solids

The total solids of morning and evening milk of Pantja goats from the 1st to 26th week revealed that minimum total solids are found in the 1st week in morning milk (12.42±0.314) and maximum in morning milk of the 25th week i.e. (15.35±0.958). The value of the present study was lower than earlier reports of total solids. Banda (1992) [2] and Mwenefumbo and Phoya (1982) [9] reported the Total solids values in goat milk as 17.7±0.09 and 16.3±1.0 percent which are lower than the present study. Nag *et al*. (2007) [10] reported 14.6±0.3 percent of total solids in Barbari goat milk. It is concluded that Pantja goat milk has the same total solid content as Barbari goat milk.

c. Solid not fat (SNF)

SNF percent of morning and evening milk of Pantja goats from the 1st to 26th week showed that the highest and lowest SNF values were noted in the morning milk of the 26th week (9.77±0.124) and 1st week (i.e. 8.78±0.099). Hassan *et al.* (2010) [6] reported the average SNF percent of Jamunapari goat milk at 1st, 2nd 3rd 4th, and 5th months of lactation as 10.0±0.8, 10.3±0.2, 10.6±0.6, 11.1±0.4, 11.8±1.5 and 10.7±0.8 percent, respectively. The SNF percent of goat milk in the present study were lower than the finding of Hassan *et al.* (2010) [6]. The present study shows the total agreement with Banda (1992) [2] and Mwenefumbo and Phoya (1982) [9] who noted SNF as 10.8±0.08 and 9.6±0.81, respectively. Cow and human milk have similar SNF percentages as that of Pantja goat milk. Whereas, sheep milk has a higher SNF percent (12 percent) than the Pantja goat milk (8.75±0.125 percent).

d. Lactose content:

Lactose percent of the morning and evening milk from the 1st to 26th week in the present study had an increasing trend till 13 wks after that it had decreasing trend till the 26th wk. While maximum and minimum lactose noted in morning milk of the 13th and 26th week are 5.05±0.179 percent and 3.43±0.12, respectively. In contrast to the present finding Hassan *et al.* (2010) [6] noted an increasing trend of lactose content throughout the lactation period i.e. first, 2nd, 3rd, 4th, and 5th month of lactate on as 5.4±0.4, 5.6±0.3, 5.7±0.3, 6.0±6.1 and 6.4±0.8, respectively. Banda (1992) [2] and Mwenefumbo and Phoya (1982) [9] reported lactose content in goat milk as 4.7±0.03 and 5.3±0.79 percent, respectively. Cow and sheep milk has similar lactose content as the milk of Pantja goats. While human milk has 6.9 per cent lactose i.e. higher than the lactose content of goat milk Posati and Orr (1976), Jenness (1980), and Haenlein and Caccese (1984) [12, 7, 5].

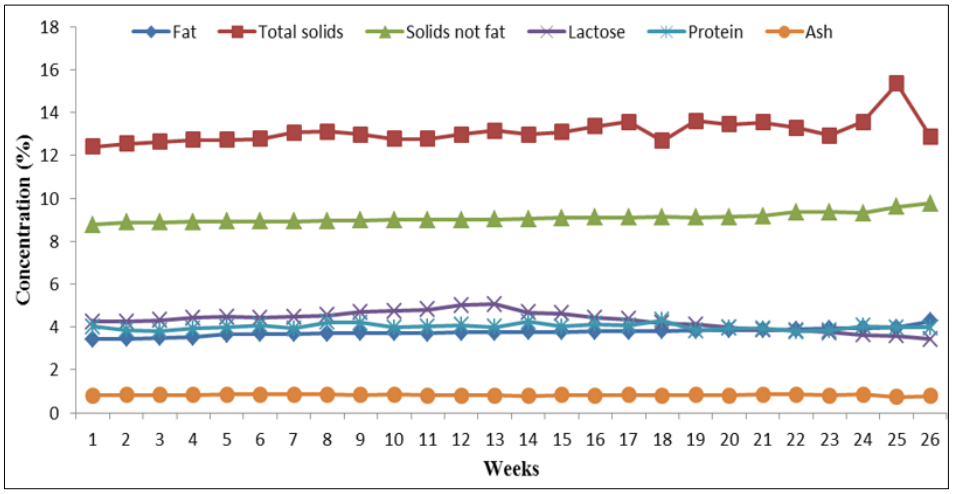

Fig 1: Chemical composition of morning milk

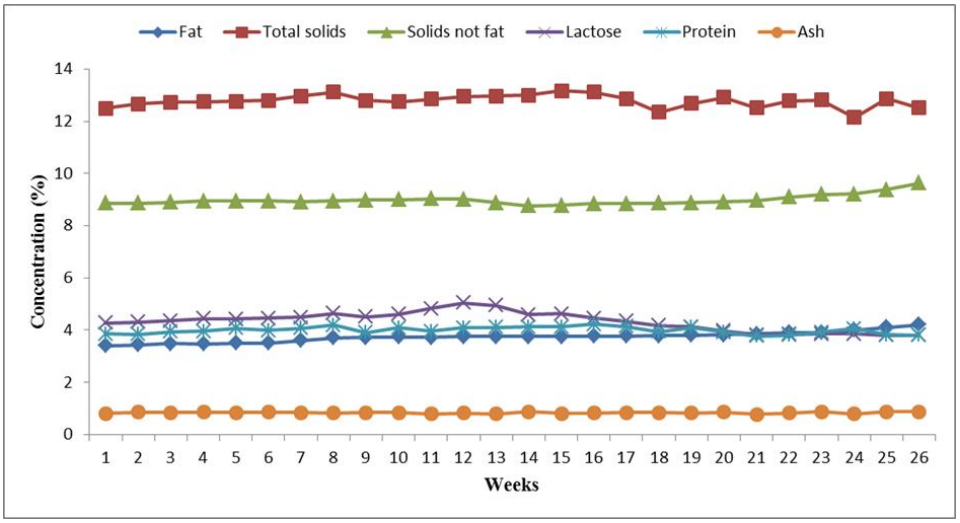

Fig 2: Chemical composition of evening milk

Table 1: Morning milk composition at weekly interval (Per cent)

WKS	Fat	Total solids	Solids not fat	Lactose	Protein	Ash
1	3.43±0.093	12.42±0.314	8.78±0.099	4.25±0.132	4.01±0.161	0.808±0.0228
2	3.46±0.088	12.56±0.252	8.89±0.174	4.25±0.146	3.87±0.113	0.825±0.021
3	3.5±0.073	12.64±0.23	8.88±0.143	4.32±0.145	3.81±0.126	0.827±0.017
4	3.52±0.084	12.74±0.245	8.91±0.157	4.42±0.115	3.92±0.128	0.839±0.019
5	3.65±0.101	12.74±0.335	8.92±0.176	4.47±0.132	3.99±0.144	0.86±0.017
6	3.67±0.124	12.77±0.302	8.92±0.115	4.43±0.133	4.08±0.155	0.859±0.027
7	3.68±0.094	13.07±0.369	8.94±0.125	4.47±0.145	3.94±0.149	0.855±0.025
8	3.7±0.106	13.12±0.395	8.96±0.144	4.54±0.179	4.22±0.137	0.852±0.017
9	3.72±0.098	12.97±0.259	8.98±0.181	4.69±0.152	4.2±0.165	0.831±0.023
10	3.73±0.088	12.77±0.344	8.99±0.168	4.74±0.139	3.98±0.167	0.847±0.021
11	3.71±0.076	12.78±0.299	8.99±0.169	4.82±0.177	4.03±0.141	0.819±0.024
12	3.74±0.073	12.97±0.362	8.99±0.229	5.02±0.141	4.08±0.145	0.8±0.023
13	3.75±0.104	13.16±0.36	9.01±0.107	5.05±0.179	3.99±0.113	0.814±0.02
14	3.77±0.107	12.98±0.279	9.05±0.271	4.67±0.141	4.24±0.147	0.79±0.021
15	3.78±0.098	13.09±0.351	9.08±0.149	4.64±0.192	4.02±0.15	0.838±0.0221
16	3.79±0.103	13.36±0.383	9.12±0.183	4.43±0.156	4.13±0.18	0.815±0.022
17	3.8±0.129	13.57±0.393	9.1±0.217	4.35±0.152	4.07±0.148	0.829±0.022
18	3.82±0.123	12.69±0.115	9.13±0.169	4.18±0.152	4.31±0.158	0.814±0.025
19	3.84±0.141	13.61±0.488	9.12±0.177	4.11±0.125	3.85±0.133	0.833±0.022
20	3.87±0.128	13.45±0.48	9.13±0.298	3.98±0.142	3.95±0.164	0.81±0.029
21	3.87±0.119	13.54±0.503	9.19±0.384	3.86±0.123	3.92±0.154	0.852±0.015
22	3.89±0.186	13.3±0.337	9.37±0.382	3.84±0.137	3.8±0.139	0.853±0.03
23	3.93±0.204	12.93±0.209	9.37±0.322	3.75±0.111	3.84±0.162	0.815±0.027
24	3.95±0.219	13.56±0.086	9.31±0.197	3.63±0.165	4.05±0.149	0.845±0.015
25	3.97±0.284	15.35±0.958	9.62±0.548	3.58±0.209	3.98±0.185	0.748±0.05
26	4.27±0.033	12.88±0.211	9.77±0.124	3.43±0.12	3.97±0.219	0.793±0.052

Tables 2: Evening milk composition at weekly interval (Per cent)

WKS	Fat	Total solids	Solids not fat	Lactose	Protein	Ash
1	3.4±0.084	12.49±0.159	8.87±0.167	4.27±0.149	3.85±0.153	0.808±0.022
2	3.44±0.089	12.66±0.246	8.86±0.267	4.3±0.159	3.84±0.137	0.851±0.018
3	3.48±0.068	12.73±0.09	8.89±0.111	4.36±0.159	3.94±0.111	0.84±0.015
4	3.47±0.089	12.75±0.259	8.94±0.152	4.44±0.157	3.95±0.121	0.859±0.016
5	3.51±0.077	12.76±0.202	8.95±0.212	4.43±0.123	4.08±0.105	0.849±0.021
6	3.5±0.112	12.8±0.309	8.94±0.186	4.46±0.121	3.99±0.109	0.86±0.024
7	3.6±0.098	12.97±0.274	8.92±0.102	4.49±0.168	4.07±0.142	0.837±0.019
8	3.71±0.065	13.12±0.322	8.95±0.144	4.64±0.195	4.19±0.136	0.828±0.023
9	3.72±0.087	12.79±0.262	8.98±0.227	4.51±0.129	3.91±0.154	0.844±0.028
10	3.74±0.067	12.74±0.25	8.99±0.205	4.61±0.137	4.09±0.163	0.837±0.025
11	3.72±0.125	12.84±0.397	9.03±0.189	4.82±0.153	3.96±0.13	0.789±0.024
12	3.7 5±0.13	12.94±0.379	9.02±0.219	5.04±0.098	4.09±0.138	0.824±0.022
13	3.75±0.104	12.97±0.306	8.88±0.139	4.95±0.109	4.11±0.139	0.799±0.019
14	3.76±0.134	13±0.451	8.76±0.178	4.6±0.169	4.12±0.183	0.875±0.022
15	3.76±0.122	13.16±0.323	8.78±0.098	4.62±0.13	4.12±0.114	0.815±0.023
16	3.77±0.123	13.12±0.41	8.84±0.154	4.46±0.099	4.23±0.138	0.818±0.025
17	3.78±0.102	12.86±0.337	8.85±0.101	4.34±0.116	4.14±0.124	0.841±0.021
18	3.79±0.067	12.34±0.128	8.87±0.121	4.18±0.135	3.94±0.159	0.841±0.024
19	3.81±0.107	12.68±0.411	8.88±0.184	4.12±0.121	4.1±0.136	0.818±0.022
20	3.83±0.099	12.92±0.273	8.91±0.068	3.97±0.097	3.92±0.204	0.852±0.019
21	3.85±0.151	12.51±0.333	8.96±0.152	3.83±0.142	3.77±0.145	0.768±0.02
22	3.9±0.157	12.78±0.319	9.1±0.317	3.84±0.168	3.8±0.104	0.822±0.032
23	3.91±0.162	12.81±0.338	9.19±0.171	3.85±0.127	3.92±0.151	0.869±0.028
24	4±0.175	12.15±0.154	9.22±0.265	3.86±0.102	4.05±0.179	0.789±0.021
25	4.1±0.296	12.86±0.342	9.38±0.3	3.8±0.129	3.83±0.143	0.875±0.031
26	4.2±0.116	12.51±0.095	9.63±0.1002	3.8±0.173	3.80±0.1	0.88±0.032

(e) Protein content

The protein content of morning and evening milk of Pantja goat was in the range of 3.97±0.219 percent to 4.3±0.158 percent. Maximum and minimum protein content was 4.3±0.158 and 3.97±0.219 percent at 18wk and 26wk respectively. The findings of Hassan *et al.* (2010) [6] were in total agreement with the finding of the present study. Banda (1992) [2] reported 4.7±0.02 percent protein in goat milk which also is similar to the protein content of Pantja goat milk. In contrast to the present finding Mwenefumbo and Phoya (1982) [9] reported 2.2±0.43 per cent protein content in goat milk. Pantja goat milk has a similar protein content as cow milk. Nag *et al.* (2007) [10] reported 4.2±0.2 percent protein in Barbari goat milk. It is concluded that Pantja goat

milk has (4.0±0.151 percent) the same protein content as Barbari goat milk protein content. While human milk has lower protein content than Pantja goat milk while sheep milk has higher protein content than goat milk.

(f) Ash content

The Ash content of Pantja goat milk was in the range of 0.748±0.05 to 0.86±0.017 percent. The finding of the present study has a total agreement with the finding of Agnihotri and Rajkumar (2007), Hassan *et al.* (2010), Banda (1992), Mwenefumbo and Phoya (1982) [1, 6, 2, 9]. Hassan *et al.* (2010) reported ash content as 0.7±0.1, 0.8±0.1, 0.7±0.3, 0.7±0.5 and 0.7±0.1 per cent in 1st, 2nd, 3rd, 4th and 5th month of lactation, respectively. While Banda (1992) and Mwenefumbo and Phoya (1982) [2, 9] reported ash content as 0.88±0.004 and 1.1±0.31 percent, respectively in Jamunapari goats. Nag *et al.* (2007) [10] reported as content of 0.9±0.05 percent in Barbari goat milk. It is concluded that Pantja goat milk has (0.83±0.024 percent) slightly lower ash content than Barbari goat milk. Cow and sheep milk has similar ash content as that of Pantja goat milk while human milk has much lower ash content than the Pantja goat milk.

Conclusion

On the basis of results obtained in the present study, it can be concluded that Pantja goat milk has lower fat and the same total solids and protein content as that Barbari goat milk. Pantja goat milk has similar SNF and lactose content as that of cow milk. Sheep milk has higher protein and SNF content and similar lactose content as that of Pantja goat milk. While human milk has higher lactose and much lower ash content than Pantja goat milk.

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