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COMPOSITION AND CHARACTERISTICS OF GOAT MILK AND ITS NUTRITIONAL SIGNIFICANCE

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The purpose of rearing goats for providing nutritional and financial sustenance to economically weaker sections of the human population is aptly recognized. Goats can thrive under extreme vagaries of nature and feed scarcity. India possesses the largest population of goat viz. 120.56 million which contributes 3 million metric ton of milk (FAO 1998) valued at Rs.250 million (estimated at Rs. 8 per kg) to the GDP. Economic returns from goat farming could be considerably increased by suitably processing raw milk to manufacture value added products, which may bring almost twice the return than currently being obtained. This may also reduce volume and increase shelf life and thus add to the area of consumption. However, there are certain peculiarities of goat milk viz. smaller size of fat globules, lower heat stability and softer curd. The adverse "goaty" odour poses technical problems in its processing and marketing. The odour can however be removed by keeping the bucks away from the does other than for detection of heat and mating. The objective of this paper is to assess the characteristics of goat milk and its significance in human nutrition.

Composition of goat milk

A comparison between composition of goat milk with that of cow and human milk is presented in Table 1. From the table, it is clear that goat milk is similar to cow and human milk with only a few exceptions.

Goat milk: general characteristics

The specific gravity of goat milk is comparable to cow milk. The freezing point of goat milk is about - 0.580°C which is lower than that of cow milk (-0.540°C). The electrical conductivity of 0.0112-0.0191 ohm^{-1} cm^{-1} in milk from Indian goats is higher than the reports in western countries. Viscosity of goat milk (13.4 mP at 27°C) is slightly lower than cow milk. The Refractive index of goat milk lies between that of cow and buffalo milk. The titrable acidity expressed as content of lactic acid ranges from 0.11 to 0.18 percent. The mean pH value ranges from 6.5 to 6.9. The curd tension of goat milk is much lower than that of cow milk. The average value with pepsin–HCl test was 36. This may account for the said better digestibility as compared to cow milk.

Physico-chemical properties of goat milk constituents

Lipids: An important characteristic of the fat globules in goat milk is that they are smaller in size than that of cow milk. Though the range of size of milk fat globules is same in cow and goat milk (1-10 in μ in diameter), the contents of smaller globules (up to 4.5μ) are more in goat milk (82.7% in goat milk & 62.4% in cow milk). Moreover, it has been established that the fat globules of goat milk do not cluster when milk is cooled, apparently due to the lack of agglutinin which is found in bovine milk. Nutritionally, the high concentration of small fat globules is an advantage, but for butter making, milk fat of goat milk is more difficult to separate than that of cow milk.

Fatty Acid Composition:Goat milk has much higher concentration of the so called medium chain fatty acid (MCT). In goat milk, the FFA (Free fatty acids) is reported to be the main source of the characteristic 'goaty' flavour. Another report states the presence of high level of short and medium chain fatty acids being responsible for the goaty flavour and majority are sensitive to heat treatment. Pasteurization can reduce this 'off flavour'.

Another group of workers, have reported that the goaty flavour in goat milk is due to the presence of buck in the flock especially at the time of milking.

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Buck's scent glands are odoriferous which cause the goaty scent in milk. This, however, is not yet proved.

Protein: The protein percentage of cow and goat milk is fairly similar. Reports say á-S_1 casein is absent in goat milk but others refute it. However, the size distribution of casein micelles when studies under electron microscope shows that goat milk casein micelles size is larger than bovine milk. Majority fall in 100-200 nm in diameter in goat casein micelles as compared to 60-80 nm in bovine. This feature could explain the peculiar behavior of goat milk from that of cow milk. The Relative compositions of essential amino acids are given in Table 3.

Minerals: Data regarding mineral contents of goat milk as compared with those of human milk and cow milk has already been presented in Table.1 The ash content ranges from 0.7 to 0.85 percent. Goat milk contains more calcium, phosphorus and potassium than cow and human milk.

Vitamins: They are comparable with those of cow and human milk.

Goat milk and milk products

Traditionally, goat milk is produced in small farms. It is worth noting that, fresh goat milk is sold as pasteurized milk and in variety of packaging in super market chains and health food shops in many western countries. In fact, fresh milk obtained under sanitary conditions from properly fed and managed healthy goats is free from objectionable flavour and odour and when off- flavour is detected, it should be attributed to mishandling of milk at some point from milking to consumption.

A special beverage from fermented goat milk has been developed in the West. The goat milk standardized to 2 percent fat and 10.5 percent SNF (using concentrated goat skim milk) was fortified with vitamin A and D to label it as protein fortified

Table 1: Composition of Goat Milk in Comparison with Cow and Human Milk (Haenlien, 2001)

Sl. No.	Particular	Per 100 gram		
		Goat	Cow	Human
1.	Total solid (%)	12.97	12.01	12.50
2.	Energy Kilocalorie	69	61	70
	Kilo Joule	288	257	291
3.	Protein (%)	3.56	3.29	1.03
4.	Lipid (%)	4.14	3.34	4.38
5.	Carbohydrates (%)	4.45	4.6	6.89
6.	Ash (%)	0.82	0.72	0.20
7.	Calcium (mg)	134	119	32
8.	Iron (mg)	0.05	0.05	0.03
9.	Magnesium (mg)	14	13	3
10.	Phosphorus (mg)	111	93	14
11.	Potassium (mg)	204	152	51
12.	Sodium (mg)	50	49	17
13.	Zinc (mg)	0.30	0.38	0.17
14.	Ascorbic acid (mg)	1.29	0.94	5.00
15.	Thiamin (mcg)	40	40	20
16.	Riboflavin (mg)	0.138	0.162	0.036
17.	Niacin (mg)	0.277	0.084	0.177
18.	Pantothenic acid (mg)	0.310	0.314	0.223
19.	Vitamin B_6 (mcg)	60	60	10
20.	Folacin (mcg)	1	6	5
21.	Vitamin B12 (mcg)	0.065	0.0357	0.045
22.	Vitamin A (mcg)	44	52	58
23.	Vitamin D (mcg)	0.11	0.03	0.04
24.	Vitamin E (mg)	0.33	0.09	0.34
25.	Vitamin C (mg)	1	1	4

low fat goat milk. Consumer acceptance of this milk is reported to be excellent.

Choa Mawa: Mawa made from goat milk is sticky and there is no release of free fat during final stages of its preparation. It is yellowish in colour with moist surface, slightly hard body and smooth texture. Its taste is slightly salty. Addition of buffalo milk (50%) improves the product.

Table 2: Relative composition of Fatty Acid in Goat and Cow Milk in Relation to Human Milk (Haenlien, 2001)

No	Particulars	Goat	Cow
1.	Saturated fatty acid	133	103
2.	C_4 : 0 butyric	1300	1100
3.	C_6: 0 caproic	900	600
4.	C_8 : 0caprylic	1000	400
5.	C_{10}: 0 capric	520	150
6.	C_{12} : 0 lauric	48	36
7.	C_{14}: 0 myristic	103	110
8.	C_{16}: 0 palmitic	99	96
9.	C_{18}: 0 stearic	152	138
10.	Monosaturated fatty acid	67	58
11.	C_{16}: 1 palmitoleic	62	62
12.	C_{18} 1 pleic	66	57
13.	Polyunsaturated fatty acid	30	24
14.	C_{18}: 2 linoleic	30	22
15.	C_{18}: 3 linolenic	80	100
	MCT – FA		
16.	C_6: 0-C_{12}:0	178	84
17.	Cholesterol	50	65

Table 3: Relative Composition of Essential Amino Acids in Goats and Cow Milk Taking Human Milk as Standard (Haenlien, 2001)

No.	Particulars	Goat	Cow
1.	Arginine	277	277
2.	Histidine	387	387
3.	Isoleucine	370	355
4.	Leucine	330	339
5.	Lysine	426	384
6.	Methionine	381	395
7.	Phenylalanine	337	346
8.	Threonine	354	324
9.	Tryptophan	259	270
10	Valine	381	349

Paneer: Good quality paneer free from goaty odour and flavor can be prepared.

Chhana: Chhana has been successfully manufactured using goat milk and this has been used for preparing Sandesh and Rasagolla.

Ice-cream: Since, goat milk products are significantly more expensive than cow milk products in the West, premium quality ice-cream can be prepared using this milk.

Infant Foods: In USA and South Africa, goat milk is sold in evaporated or spray dried form for pediatric use.

Yoghurt: Literature says that goat milk Yoghurt is available on most supermarket shelves. It was a steadily expanding market among the growing section of consumer seeking health and specialty foods. The characteristic goaty flavour is completely masked in goat milk yoghurt. Another positive aspect is that it does not show any 'wheying off' at 4°C storage as in case of non-homogenized cow milk yoghurt.

Ghee: Goat milk is generally considered not suitable for the manufacture of ghee, the main reason being its relatively small fat globules which pose a problem during separation and its typical flavour. In addition, ghee from goat milk is greasy. So, blending of goat milk with buffalo milk in 1:1 ratio yields good quality ghee. Some workers reported the unsuitability due to the higher concentration of C_4-C_8, C10- C_{12} and lower percentage of long chain (C_{16}-C_{18}) fatty acids.

Cheese: The most important cheeses made from goat milk include soft and semi-hard varieties. In many European countries, this cheese is being marketed as 'Premium Cheese'. The greater proportion of MCT offers these premium cheeses because of a sharper flavour for which they are known for.

Dietary and medicinal significance of goat milk

Goat milk has been recognized for its value in infant feeding. In USA and South Africa, goat milk is sold in evaporated or spray dried form for pediatric use.

Sensitivity for cow milk usually became apparent in early infancy and the symptoms are

gastro- intestinal disturbance like vomiting, colic, diarrhea or constipation. On the respiratory side one may find an allergic rhinitis manifested by a blocked, stuffy or a running nose. As far as skin conditions are concerned, one may find urticaria, angioneurotic edema or anatopic dermatitis.

Studies conducted on the molecular structure of protein of goat milk proved beyond doubt that all the casein fractions differed widely in basic chemical structure from that of cow milk and it is the only reason why infant intolerant to a product from cow milk does so well on goat milk. Clinical evaluation revealed that goat milk was well tolerated by infants with gastrointestinal or respiratory symptoms and even those who suffered shock from ingestion of cow milk. Success rate is more with pasteurized goat milk. FAO has reported that since heat denaturation renders milk less allergic, a fortuitous combination like evaporated goat milk seems to be an ideal substitute food for infants allergic to cow milk. In another study, 40 percent of the patients sensitive to cow milk protein were able to tolerate goat milk protein. An allergy to goat milk is very rare. Further, fermented product from goat milk can replace those of cow milk in diet of people suffering from allergy to cow milk.

Goat milk is naturally homogenized and forms a softer curd that can get digested very quickly and easily. In a study in growth conducted in children and rats, significantly better gain in weight, height and skeletal mineralization, vitamin, mineral and hemoglobin levels were observed for goat milk compared to cow milk. Medium chain length fatty acid or Medium Chain Triglycerides (MCT) which are more in goat milk have been recognized as unique lipid with unique health benefits in malabsorption syndromes, chyluria, steatorrhea, and in cases of intestinal resection, coronary bypass, premature infant feeding, childhood epilepsy, cystic fibrosis and gallstones. MCT also inhibits or limits cholesterol deposition, dissolve cholesterol gallstones and contributes to normal growth of infants.

Conclusion

In conclusion, it can be said that despite a significant role of goat in rural economy and health, goat has remained neglected in research and development because of misunderstood role of goat in decertification. To access and exploit it to its full potential, there is an urgent need for further research and development of goat for meat and milk, particularly the role of goat milk for its medicinal value.

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