



Immune status in goats

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Abstract

Goats are the most important and beneficial animal for common rural people of India for their nutritious milk, delicious meat and leather. Goats are having huge potency to help the poor population of India as well as of rest of the world. Thus, at least for India, goats are regarded as “Poor Man’s Cow”. Despite of being such an economically beneficial animal, the health management of goats was mostly neglected by veterinarians for a long period of time. Further, goats are the ruminant short day breeders and seasonality in terms of reproduction and immunity is prevalent in this animal. Being the ruminant free grazing animals they are susceptible to different season bound diseases which are mainly caused by different viruses, bacteria and protozoan. Physiologically goats are very much similar to that of human particularly for gestation type and to some extent the duration. Similarly, in terms of immunity research the goats are emerging as more humanitarian animal model than those of rats, mice, zebra fishes and flies. But, till date reports are limited considering the immune regulation and reproduction in this animal model. Thus, goats can be an alternative and high throughput animal model not only for the benefit of common mass but also to act as an alternative model representing the human.

Keywords: Alternative; Animal Model; Immunity; Goats

Introduction

Goats were the earliest animals to be domesticated during Neolithic times along with the cultivation of cereals. Following the domestication of cattle and pigs, draft animals such as horses and asses were also domesticated. The Harappa toys contain the representations of goats. Two seals from Mohenjo-daro show a wild bezoar goat with enormous curled horns and a bearded domestic male goat with side-spreading horns. The Gaddi goat, which greatly resembles the ancestral wild goat, was used as a beast of burden in the mountains and is still used in the Himalayan region of India for carrying salt and food grains. In the Indo-Gangetic plains, goats were among the first ruminants to be domesticated in 2000 BC. The wild goat (*Capra hircus*) was the chief ancestral stock from which the various breeds of domestic goats were originated. Then they had a wide distribution from the barren hills of Baluchistan to the western Sind. The domestication of the goat species, their movement and distribution across continents have resulted in the evolution of nearly 570 breeds throughout the world which includes pure and cross-bred goat population. Till date the available data regarding the goat breeds suggests that out of 570 breeds; 187 (33%) breeds are found in Europe, 146 (26%) breeds in Asia and Pacific region and 89 (16%) breeds in Africa (Scharko, 2008). All these totally

comprise 422 breeds. But the exact data for remaining 48 breeds are under controversy. Speculatively they are either wild breeds or on the verge of extinction having only a few numbers of individuals are remaining (www.fao.org) [1]. Goats are the most helpful friends to poor people because of their prominent role and contribution in the developing countries’ economy. Goats contribute to the subsistence of small holders and landless rural poor. Goats are short day breeder ruminant and taxonomically belonging to the class mammalia order Artiodactyla, sub-order Ruminantia, family Bovidae and genus, *Capra*. Goats are cosmopolitan and found across all agro-ecological environments and nearly in all livestock production systems [2]. Goats are suitable for very extensive to highly mechanized production system [3]. India is bestowed with 17% of total world’s goat population comprised of 21 recognized and many non-descript local breeds [4]. Small ruminants are useful in many ways because of their role in income generation, food supply (meat and milk), and financial security for the poor goatherds in rural areas [5]. With the expansion of human population coupled with urbanization, has created crisis of food materials and demand for meat per capita increased in recent years. Even if it is continued to produce livestock and their products at the current rate, there

will be a lag between the production and demand of bio-food for expanding human population. In the tropics and sub-tropics, the interest in goat production has grown only in recent years. In the bio-industry, goats are underutilized and poorly understood resource even more under estimated in terms of veterinary research. A fair understanding of goat physiology and its industrial capabilities and economic outputs will be helpful in increasing the overall productivity of tropical goat farming systems. Despite of the large goat population, diversity and their economic significance, the caprine research in India particularly to the indigenous goats has been neglected by ruminant researchers. Although small ruminants are a major component of the livestock sector in most parts of the world including India, yet the information about goats and its physiology is very limited and fragmented. The importance of small ruminants for meat production in the tropics was well recognized by Payne (1990) [6]. However, small-ruminant production has some constraints and disease, which are associated with high mortality, decline in productivity and reproductive performance and even public health concerns [7,8].

Socio-Economic Significance

Due to increase in human population and increase in demand for additional animal proteins, ruminant livestock need to provide these proteins since ruminants convert inedible roughages and crop by-products/residues into desirable human food.

- a. Goats can live in ecology where grazing material is scanty. In pastoral and agricultural subsistence societies, goats are kept as a source of investment and as an insurance against disasters to meet urgent family needs.
- b. To develop a small goat farm the initial investment is much lower than cattle and buffalo. Further they attain low operating cost at semi subsistence level, smaller body size, docile nature, least manage mental problems and treatment cost are some basic economic issues which further go in favor of goat farming.
- c. Early sexual maturity, lower age at first kidding (10-12 months) and multiple births in well managed goats are economically most important. Goats in general are prolific breeders.
- d. The genetic variability is much higher which helps in selection for improved productivity.
- e. In drought prone areas and in cold alpine pasture region, and also in the migratory flocks, their mortality is comparatively high. But, due to their prolific breeding capability, goats recover their flock size quickly and thus, there is a less risk in goat farming.
- f. Among small ruminants both male and female goats have equal values. Males and sterile females have high demand as meat animal while females are used to replenish the stock quickly.
- g. Goat milk is a source of food for the poor goat farmers and also to many urban settlers for their household consumption. Goat milk has a higher content of vitamin A than cow milk.

An important feature of goat milk is that unlike cow milk, it contains no precursors of vitamin A, the vitamin being present intact.

- h. Small ruminants particularly the goats do not compete with human food and produce good quality of meat, milk, wool and pashmina. As a result, the cost of production is quite low.
- i. It acts as seeding machine especially for hard-coated seeds of trees and grasses. While passing through the animal gut, the hard coats of seeds are softened and get pelleted. In monsoon such manure coated seeds easily germinate and establish.
- j. Under proper management, sheep and goats can improve and maintain grazing land, soil fertility and reduce bush encroachment (biological control) without causing harm to the environment.
- k. Smaller body size of goats makes slaughter and dressing of carcasses easier. Goat meat is lean in character, therefore, good for fat and energy conscious people.
- l. Goat milk contains smaller fat globules which is naturally homogenized and is easily digested by infants. Many individuals, who are intolerant to cow or buffalo milk due to milk protein allergy, get relief from goat milk consumption.
- m. Goats provide more meat and milk/unit live weight/year than that of cattle and camel.
- n. Goat manure, rich in nitrogen and phosphoric acids, is a good bio-fertilizer. The urine is also rich in nitrogen and potassium.
- o. Unemployment is a big problem in the villages. To partially overcome these problems, milch goats could provide gainful employment, especially for the women and children who can easily manage a small docile goat.

Threats to the Goat Farming Industry in India: The Veterinary Aspect of Significance

Goats are important species of livestock for India. Their role in the economy of the rural resource poor in India and economic losses due to mortality and morbidity at micro and macro level is important. Goats contribute more than 52% of households' total income towards nutrition and food security of the family of goat keepers [9]. Goats are especially important to underdeveloped countries as they can easily thrive in harsh climates where other livestock animals are not able to survive. There are around 502 million of goats in the world and majority of them (90%) are located in underdeveloped countries [10]. But, as free grazing animals goats are susceptible to many diseases, even though they are often said to be the healthiest looking animals in India. Many diseases can be successfully controlled through good feeding, management and vaccination but conditions such as mastitis may be difficult to control. Thus, now it is contextual demands to list a number of diseases which are mostly prevalent in Indian goats (Table 1).

Table 1:

S.N.	Disease	Causing Factor(s)	Symptom(s)	Treatment
1	Acidosis	Ingestion of large amount of foodstuffs	Depressed and dripping head, muscle twitching, swelling on left flank and may grind teeth	Avoid food and provide Sodium bicarbonate in optimum dose (2-3 ounces/ dose).
2	Blackleg or Clostridial Myositis	Soil-borne bacterium, <i>Clostridium chauvei</i> . The disease develops rapidly in affected animals and often deaths.	High fever, lack of appetite, depression, swelling in head and the muscles on various parts of the body.	Vaccinate the goats against the diseases; affected animals may be treated with penicillin or other antibiotics according to veterinarian
3	Bloat	Due to overgrazing of wet grasses	Tightly inflated flanks	Provide the animal with Mineral oil, make the animal walk and massage flanks
4	Bottle Jaw	Infection of blood-sucking worms	Dropping the head and swelling the jaws, gum loses the normal colour due to anaemia.	Strong worming medicines every 11 days for three times. For anaemia, iron and vitamins along with antibiotics
5	Caseous Lymphaden-itis (CL)	Infectious. Bacteria enters animal through break in skin or mucous membranes and settles in lymph node.	Abscesses of the lymph glands.	Remove the animal from the flock. Abscesses and discharge must be removed and destroyed. Clean the affected area with iodine for several times. Wear the protective gloves.
6	Coccidiosis	Coccidia parasites, occurs in young and stressed animals.	The affected animal stops feeding, suffers from bloody diarrhoea, fever, rapid weight loss, straining in attempts to pass faeces,	Treatment with Biosol is effective.
7	Enterotoxaemia (overeaters' disease)	Poison produced by <i>Clostridium perfringens</i> type D in the digestive tract.	Sudden loss of appetite with high fever and watery diarrhoea, unable to stand and lies on side making paddling movements.	Provide mixed electrolyte solution with bicarbonate Commercially available type C and D antitoxins check the bacterial proliferation.
8	Floppy Kid Syndrome	Either over drinking of milk or <i>E. coli</i> .	Depression and weakness of limbs along with drunken behaviour progressive flaccid paralysis, distension of the abdomen	Remove the source of milk immediately for 24-36 hrs. Repeated oral administration of either sodium bicarbonate or electrolytes. Run the wide spectrum of antibiotics to prevent secondary bacterial infections. If not possible to remove from milk, provide the animal one-half teaspoon of baking soda with the same amount of Pepto-Bismol mixed with electrolytes.
9	Foot and Mouth disease	Viral disease of cloven-hoofed animals.	Blisters formation on lips, tongue or teats along with excessive salivation.	Must be controlled from occurring. Animals exposed to the disease are destroyed.
10	Foot Rot disease	The hooves are infected with <i>Fusiformis nodosus</i> resulting inflamed lamina.	Mild to severe lameness with a foul smell. Unable to walk.	Trim the under run hooves. Treat the infected area with antiseptic agents.
11	Gastro-intestinal round-worms	Infect stomach and intestines, sucks blood or absorbed food and decrease the absorption of digested food	Diarrhoea along with weight loss and anaemia	Treat the animal with de-worming agents like Ivomec, Cydectin.
12	Goat Polio	Deficiency of Vitamin B1 due to low roughage feeding.	Excitability, head against wall, convulsions if untreated, dies within 24-72 hrs.	Thiamine is the only effective therapy.
13	Indigestion	Over eating of concentrate food stuffs.	Do not ruminate and show sluggish behaviour.	The animal is offered a quart of salted water with 25 g of sodium bicarbonate dissolved in it.

14	Johne's Disease	Incurable infection of bacteria <i>Mycobacterium johnei</i> in the intestine. The wall of intestine thickens.	Scouring becomes more frequent with bubbles of gas in the droppings. Weakness.	Incurable. Slaughter the affected animal immediately to prevent spread of the disease.
15	Ketosis	Due to lack of energetic food, ketone bodies are accumulated in the blood of lactating doe.	Stop feeding, decrease in milk yield. Sweet smell in the goat's breath	A glucose drench may be given. Corticosteroid drug and oral propylene glycol are administered.
16	Lice	Ecto-parasite	Intense irritation, rubbing and itching, more common in winter	Acaricidal baths and insecticidal spray are repeated.
17	Laminitis	Consumption of a highly concentrated forage diet. Also appears during the infections such as pneumonia, mastitis and metritis.	Inflammation of the skin layers around the hoof the animal has a stiff gait and prefers to lay down or stay on knees.	Feed a reduced protein and energy. Treat the animal with pain killer (Non-steroidal anti-inflammatory drug) such as Phenylbutazone.
18	Listeriosis	Infected with bacteria <i>Listeria monocytogenes</i> present in soil, water, plant litter, silage and also in goat's digestive tract.	Depression with low appetite, fever, moving in one direction only, one sided facial paralysis, abortions	Treat the animal with penicillin every 6 hours for 3-5 days, then daily for another 7 days.
19	Lungworm (parasitic pneumonia)	Worms inhabit the wind pipe leading to inflammation	Persistent cough	Saturate with de-wormer such as Ivomec. Consult the animal doctor.
20	Mange or Démodé tic	Infection of hair follicles and sebaceous glands of the skin with <i>Demodex caprae</i>	Cyst like lumps in the skin.	No any effective treatment still now. Take advice of the veterinary doctor.
21	Mange or Psoriatic	Infected ear due to <i>Psoroptes caprae</i>	Head-shaking and scratching.	Flood with de-wormer such as Ivomec. Consult the animal doctor.
22	Mange, Sarcoptic	<i>Saroptes scabiei</i> burrows in the skin and lays its eggs in tunnels.	Intense itching, Skin becomes raised, red and hairless round the eyes, ears and nose.	Horizontal migration of infection. Proper treatment is required.
23	Mastitis	Inflammation of the udder due to germs infection.	Stressed animal, udder becomes hot, hard and tender along with appetite loss	Antibiotics and supportive therapy are helpful.
24	Mastitis (gangrene) -	Inflammation of the udder due to germs infection	Gangrene mastitis if the udder is cold and swollen with an excessive accumulation of fluid. The milk of the animal is watery or bloody.	Consult the animal doctor.
25	Mycotoxin	Poisoning of the animal due to fungus grown over old hay or food stuffs.	Excessive salivation, depression, anorexia and convulsions.	Administration of activated charcoal or mineral oil inhibit further uptake of mycotoxin from the gut.
26	Navel Ill	Infection of the navel cord after birth due to unhygienic environments	Swollen and painful reddish navel	Antibiotic injections along with cleaning of the affected area with antiseptic iodine. Drain the collected pus.
27	Pneumonia	Infection of the lung	Refuses food, Congestion in vocalization, Fever and coughs. Breathes rapidly or with difficulty.	Antibacterial drugs such as Oxytetracycline. Consult the animal doctor.
28	Pregnancy Toxemia	A metabolic disease of does in late pregnancy due to most of the energy in route towards foetus and kids (similar to Ketosis).	Lethargy, losses of appetite, swelling of feet. Lying around, Sweet-smelling (ketotic) breath.	Propylene glycol twice a day an benefit the doe. Mixture of sodium bicarbonate with water also relaxes the goat. Help the goat moving around during the day and feed her.
29	Ringworms	Due to fungal infection	Grey-white crusty skin without hair. Itching may occur.	Fungicidal preparations of 0.5% Lime sulphur, 1:10 bleach, 1:300 Captan and 1% Betadine is helpful.
30	Sore Mouth	Highly infectious viral disease to animals and humans.	Pimples around nose, mouth, eyes, anus and hooves. Turning from watery blisters to sticky and encrusted scabs. Swelling of mouth and gums. Animals die if unable to eat.	Apply antibiotic spray or ointment. Isolate infected animals. Caccinate all the goats with Ovine Ecthyma Vaccine against sore mouth infection.

31	Tapeworms	Inhabit the small intestine	Presence of tape worm segments in the goat's droppings confers the infection. Loss of appetite and weakness occur.	An antihelmintic such as albendazole can be used. Oral niclosamide is highly effective.
32	Tetanus (lockjaw)	Infection of open wounds by the bacterium <i>Clostridium tetani</i>	Increase in muscle stiffness resulting in an unsteady gait. Convulsions may occur and die of inability to breathe.	Treatment with penicillin and anti-sera but response is poor. The wound should be opened to the air and flushed with hydrogen peroxide and infiltrated with penicillin.
33	Urinary Calculi	A collection of mineral salts in the urinary tract due to a dietary mineral imbalance. More frequent in bucks.	Restlessness and painful (vocal sign) urination, pawing the ground and recurrent looking at its own abdomen.	Get the animal treated by veterinarians. Often the penile tip is removed.
34	White Muscle Disease	Deficiency of Vitamin-E and Selenium	Weakness and trembling. Back legs become stiff. Can result in death	Administration of selenium together with vitamin E.
35	Q Fever	Caused by bacteria, <i>Coxiella burnetii</i> , a rickettsial organism capable of being transmitted from animals to people and found in sheep, cattle, goats, cats, dogs along with some wild animals (including many wild rodents), birds, and even in ticks.	Animals shed the organism in their urine, feces, milk, and especially in their birth products. Abortion or stillbirths occur in late pregnancy but only when the placenta has been severely damaged.	The affected animal is given oxytetracycline (20 mg/kg IM or SC) or Bio Mycin 20. Placentas and aborted fetuses are destroyed by burning to prevent further horizontal infection.
36	Listeriosis	Caused by <i>Listeria monocytogenes</i> , an ubiquitous organism having a wide distribution in soil, water, plant litter and digestive tract of ruminants.	Abortions occur after three months of pregnancy. The causal organism is found in contaminated silage.	Bio Mycin 200 is the most effective antibiotic. Beside this, the addition of chlortetracycline to the foodstuff is effective to check the abortions during a listeriosis outbreak.

Prevention Strategies

Some of the basic principles and practices are generally followed by the common goat raisers in India in reducing the potential hazards of goat diseases which are as follows:

- a. The disease free animals are generally purchased and are kept isolated for a week (quarantine).
- b. The disease free animals are kept away from infected animals as much as possible.
- c. Health hazards until they are accurately diagnosed.

Immunization in Goats

Vaccinations are an integral part of the livestock health management program. They provide cheap insurance against diseases that commonly affect sheep and goats. Probably, the only universally recommended vaccine for goats is CD-T. CD-T toxoid that provides three-way protection against enterotoxaemia (overeating disease) caused by *Clostridium perfringens* types C and D and tetanus (lockjaw) caused by *Clostridium tetani*. Seven and 8-way combination vaccines for additional clostridia diseases such as blackleg and malignant edema are available, but generally not necessary for small ruminants. For betterment of does and to provide passive immunity to their off springs through the colostrums; does are vaccinated 2 to 4 weeks prior to parturition. However, females giving birth for the first time are vaccinated twice in late pregnancy, about four weeks apart. Maternal antibodies will protect kids for about two months, if offspring have ingested adequate colostrums.

Kids should receive their first CD-T vaccination when they are 6 to 8 weeks old followed by a booster 2 to 4 weeks later. If pastured animals are later placed in a feed lot for concentrate feeding, producers should consider re-vaccinating them for enterotoxaemia type D. If the kids whose mother was not vaccinated for C and D, kids are required to be vaccinated with some success at two to three days of age and again in two weeks. However, vaccinations in later age will be more successful since during much young stage, cloistral antibodies interfere with vaccinations and get failed. A better way is to vaccinate the offspring from non-vaccinated dams at 1 to 3 weeks, with a booster 3 to 4 weeks later. Anti-toxins can provide immediate short-term immunity if dams were not vaccinated or in the event of disease outbreak or vaccine failure. For the sore mouth (contagious etyma), a viral skin disease commonly affecting sheep and goats, live vaccines are effective. Since vaccines against sore and mouth diseases are live vaccine, handling must be proper with use of gloves. Foot rot and foot scald is one of the most ubiquitous diseases in goat. It causes considerable economic loss due to the costs associated with treating it and the premature culling of affected animals. Foot rot vaccines should be administered every 3 to 6 months and especially prior to anticipated outbreaks of hoof problems (i.e. prior to the wet/rainy season). Abortion is when a female loses her offspring during pregnancy or gives birth to weak or deformed babies. There are vaccines (individual and combination) for several of the agents that cause abortion in sheep: enzootic (*Chlamydia sp.*) and vibriosis (*Campylobacter fetus*). Abortion vaccines should be administered prior to breeding. Risk factors for abortion include an open flock and a history of abortions

in the flock. Since the disease-causing organism is carried by domestic cats, the best protection is to control cat population by and keeping cats from contaminating feed sources. Rabies is one of the deadly diseases though the risk to goats is usually minimal and hence, rabies vaccination may be considered if the flock is located in a rabies belt. The cost of the rabies vaccine relative to the value of the animals should be considered as well. The large animal rabies vaccine has been approved to use for sheep but currently there is no licensed rabies vaccine for goat. Hence, the best way is to vaccinate all the dogs and cats. In order for vaccination programs to be successful, label directions must be carefully followed and vaccines need to be stored, handled, and administered properly. Only healthy livestock should be vaccinated. It is also important to note that vaccines have limitations and that the immunity imparted by vaccines can sometimes be inadequate or overwhelmed by disease. Scientists are currently working on vaccines to protect small ruminants against worms.

Limitation of Immunization in Goats

In India and almost all over the world the most extensive study has till date being conducted with special emphasis on immunization in ruminants and goats in particular. Thus, the veterinary significance of goat immunity can be regarded as partially explored. But, in rural India, goat farmers are not familiar with the vaccination against diseases and hence the goats' mortality is quite high due to several lethal bacterial and viral diseases along with pneumonia in various forms (particularly pulmonary adenomatosis). Enterotoxaemia, anthrax, pneumonia, clostridia diseases and lumbar paralysis in goats result in high mortality. Internal and to some extent external parasites also cause large morbidity and economic loss to goat farmers in developmental countries like India. Most mortality is due to liver-fluke infestation due to which animals become quite weak and died of gastro-intestinal problems. There are several diseases that cause their untimely death in goats. Thus, it is need of time, context and obviously of economy to explore out the most details of immune organs of goats and to pin point the factors which regulates the multi-factorial regulation of open circuit of immune system.

Conclusion

Goat research in India as well as in the global scenario is an extremely unique and emerging field of research. However, as a limitation it is only confined to the enhancement of milk, meat and productivity development of this animal. But, as a striking animal which shares physiological similarity with human particularly in terms of immunity is a new field of research. Thus, further in depth research is needed not only to increase the mortality of this animal but also to use it an alternative model organism for immunity research for the benefit of human beings.

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