

Dermatopathology of Caprine Scabies and Protective Immunity in Sensitised Goats Against *Sarcoptes scabiei* Reinfestation

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ABSTRAK

TARIGAN, S. 2002. Dermatopatologi dan imunitas protektif pada kambing yang sebelumnya telah disensitisasi terhadap infestasi ulang *Sarcoptes scabiei*. *JITV* 7(4): 265-271.

Tujuan dari penelitian ini adalah membandingkan gambaran dermatopatologi makroskopis yang terjadi pada kambing yang *naïve* dan yang sudah disensitisasi oleh tungau skabies, dan menaksir derajat kekebalan yang dimiliki oleh kambing yang sebelumnya telah disensitisasi terhadap infestasi ulang *Sarcoptes scabiei*. Sebanyak 18 ekor kambing dibagi menjadi 3 kelompok secara merata; kelompok 1 disensitisasi dua kali, kelompok 2 disensitisasi sekali dan kelompok 3 tidak disensitisasi (*naïve*). Sensitisasi dilakukan dengan cara menginfestasikan tungau pada daun telinga, infestasi dibiarkan berjalan sampai skabies menjadi parah, kemudian kambing diobati dengan Ivermectin sampai sembuh. Setelah itu, semua kambing baik yang telah disensitisasi ataupun yang *naïve* diinfestasi dengan tungau pada daun telinganya. Infestasi tungau pada kambing yang disensitisasi telah menghasilkan reaksi hipersensitif cepat (*immediate hypersensitive*) yang hebat berakibat timbulnya dermatitis pustular perakut yang parah. Akan tetapi, setelah satu minggu lesi tersebut mengalami proses penyembuhan secara perlahan-lahan. Tujuh minggu pasca infestasi lesi yang tersisa hanya berupa papular dermatitis ringan, demikian ringannya sehingga hanya dapat diketahui dengan memalpasi tempat infestasi. Sebaliknya pada kambing yang *naïve*, infestasi menimbulkan lesi yang progresif yang berakhir pada *crusted scabies* yang parah meliputi hampir semua kulit. Antigen yang bertanggung jawab atas terbentuknya reaksi hipersensitif cepat tersebut, yang diduga terkandung dalam sekresi atau ekskresi tungau, secara imunologis protektif tetapi kemungkinan besar tidak mampu menginduksi proteksi yang lengkap. Hal ini didasarkan pada hasil penelitian bahwa kambing yang disensitisasi dua kali tidak memiliki imun protektif yang lebih tinggi dari kambing yang hanya disensitisasi sekali.

Kata kunci: *Sarcoptes scabiei* var. *caprae*, sensitisasi, imunitas protektif, hipersensitif cepat

ABSTRACT

TARIGAN, S. 2002. Dermatopathology of Caprine Scabies and Protective Immunity in Sensitised Goats Against *Sarcoptes scabiei* Reinfestation. *JITV* 7(4): 265-271.

The purpose of this study was to compare macroscopic dermatopathology in naïve and sensitised goats, and to assess protective immunity possessed by sensitised goats against *Sarcoptes scabiei* challenge. Eighteen goats were allocated evenly into 3 groups; group 1 sensitised with the mite twice, group 2 once and group 3 was not sensitised (*naïve*). Sensitisation was done by infesting goats with the mites on the auricle and infestation was allowed to progress for 7 weeks, then the goats were treated with Ivermectin to obtain complete recovery. After sensitisation, all sensitised and naïve goats were infested with the mites on the auricles. Infestation in the sensitised goat caused severe immediate hypersensitivity that resulted in severe peracute pustular dermatitis. After one week, however, the lesion waned slowly. At 7 weeks post infestation, the remnant of lesion could only be perceived by palpation on the primary site of infestation as a mild papular dermatitis. Infestation on the naïve goats, in contrast, produced slowly progressing lesions which at 7-week post infestation, it ended up with severe crusted scabies affecting almost the whole skin. Antigens responsible for the immediate hypersensitivity which are supposedly contained in the mite secretions or excretions are immunologically protective but unlikely to have the capacity to induce a complete protection against mite challenge in immunised animals. This notion is based on the fact obtained from this study that goats sensitised twice did not possess a higher immune protection against mite challenge than goats sensitised once.

Key words: *Sarcoptes scabiei* var. *caprae*, sensitisation, protective immunity, immediate hypersensitive

INTRODUCTION

Sarcoptic mange is one of the most economically important diseases in goats in Indonesia. The annual reports of provincial livestock services and the regional veterinary laboratories usually indicate that sarcoptic

mange is the most prevalent disease in goats. This means that the disease appears to be the most prevalent and present all the time wherever goats are raised in Indonesia. The prevalence of the disease in a goat population appears to fluctuate considerably, from less than 5% to nearly 100%. The mortality rate of the

disease is reported to be surprisingly high, 67-100% in young and around 11% in mature goats (BROTOWIDJOYO, 1987; MANURUNG *et al.*, 1987). A high prevalence of sarcoptic mange is also reported in Malaysia (DORNY *et al.*, 1994), India (PARIJA *et al.*, 1995) and Libya (GABAJ *et al.*, 1992).

In spite substantial losses inflicted by this mite, control measures that have been developed against the ectoparasites are limited. The means of controlling disease in animals and human rely on the treatment of affected animals with acaricides. It is well realised, however, that this practice especially in goat is unsatisfactory. Acaricide applied topically is not only tedious but also endanger the personnel who apply it. Some acaricides that have been used for many years to treat sarcoptic mange, such as Asuntol[®], is no longer available in the market. It is true that Ivermectin is both effective and easily to be applied (by injection) but this drug is too expensive for goat farmers in Indonesia (MANURUNG *et al.*, 1990).

Because of the danger posed by heavily dependent on pesticides, alternative technologies that are sustainable are desperately needed. Control by immunologic intervention or vaccines are considered to be the most practical that fulfill the criteria of sustainable control measure because they should be specific against their target parasite with effects limited to the individual vaccinated host animals (DONALD, 1994). Nevertheless, development of vaccine against metazoan parasites is much more difficult compared to that against viruses or bacteria. This is because of the complexity interactions between the parasitic immunogenicity and the host immunological responses. The parasites and host are in a dynamic equilibrium that allows both to survive, although usually with severe consequence for the host (WILLADSEN, 1997). Furthermore, identification of protective antigen that can be used as vaccine component, and production of the antigen in the right form and cheaply are difficult, time consuming and costing.

The purpose of the present study is to investigate the immunity developed in goats infested with *S. scabiei*. Previous studies have indicated that men, rabbits or dogs recovered from scabies possess protective immunity against mite challenge (MELLANBY, 1944; ARLIAN *et al.*, 1994a,b; ARLIAN *et al.*, 1996). The present study is designed to determine whether similar phenomenon also occurs in goats and whether the immunity could be enhanced by infesting or sensitising goats more than once. Results of this study would be necessary in providing some clue of whether sarcoptic mange might or might not be feasibly vaccinated, and if it is feasible to indicate which mite components potentially act as protective antigens.

MATERIALS AND METHODS

Source of mite

A goat suffered from severe sarcoptic mange was purchased nearby farm. After confirming microscopically that the mange was caused solely by *S. scabiei*, not by other mites, the goat was used to infect healthy goats by housing them together in the same pen. This colony of mangy goats was maintained as source of mite for infestation of experimental animals.

Experimental infestation

A severe mangy goat was euthanised by removing all the blood by venipuncture. After clipping and shaving the hair, skin showing encrustation dermatitis was scraped deeply. The skin scrape was chopped to about 2 mm³ or less and mixed thoroughly and kept at 4°C overnight. The number of mite per gram of skin scraping was determined by placing the skin scraping at the edge of a Petri disk. A beam of light was directed to the centre of the Petri disk, and mites migrating toward the light were counted under a microscope after 6 hours.

A piece of cloth (6 x 4 cm²) was placed on the convex surface of a goat auricle, the bottom, left and right rims of the cloth were attached to the auricle by adhesive tape. Skin scraping containing approximately 2000 mites was inserted under the cloth through the top edge then the top edge was attached to the auricle. After 48 hours, the cloth together with the skin scraping were removed and infestation was allowed to progress.

Goats and sensitisation

Six young female, apparently healthy, local breed goats were purchased from premises with no history of previous mange infestation. These goats were allocated to be the group with twice sensitisation with the mite (Group 1). After 2-week adaptation to the laboratory condition, the animals were infested on the left auricle with approximately 2000 mites then infestation was allowed to develop. Seven weeks after the infestation, at which mangy lesion become very severe, the goats were injected with 0.5 ml Ivermectin (MSD AGVET, Holland) subcutaneously. Complete recovery was obtained by repeating the injection 1 and 2 weeks later. Three weeks after the last injection, goats were infested with the mite for the second time.

Two weeks before the second infestation, another 6 healthy, young female goats were purchased and adapted to the laboratory condition. These goats, which were allocated to be the Group 2 in the experiment,

were infested with the mite at the same day as did group 1. Again, 7 weeks after infestation, all goats were treated with Ivermectin to obtain complete recovery. Just before the completion of the sensitisation, still another 6 healthy, young, female goats from mange free premises were purchased and adapted to the laboratory condition. These goats were not sensitised and allocated to be the naïve group (Group 3).

Challenge and immunity determination

To access protective immunity possess by the sensitised goats, and to compare gross pathology in sensitised and naïve goats, all groups were infested on the left or right auricle with approximately 2000 mites. The development of lesion was examined at 48 hours, and then every 10 days after infestation. Severity of lesions was determined with the following scores: score 0 if no lesion, score 1 if the infested auricle affected by dermatitis less than 10%, score 2 if the auricle

contained 10 to 50 % dermatitis, score 3 = 50-75%, score 4 = 75-100%, and score 5 if >75% of the infested auricle and also other parts of the body were affected by dermatitis.

RESULTS

Clinical and pathological changes manifested by sensitised goats infested with *S. scabiei* were remarkable different to those exhibited by naïve goats infested similarly. Lesions in sensitised goats developed rapidly and then waned slowly, whereas in the naïve goats the lesions progressed slowly but steadily. At the end of the experiment (50 days post challenge infestation) lesions in sensitised groups were almost invisible, the remnant of the lesions could only be perceived by palpation of the infested auricle. Whereas, lesions in the naïve group were very severe, affecting almost the whole skin (Table 1).

Table 1. Severity of lesion in sensitised and naïve goats due to infestation of *Sarcoptes scabiei*

Goat group and number	Stage of infestation					
	1 and 2 days	10 days	20 days	30 days	40 days	50 days
Group 1 (2 x sensitised)						
27	4*	3	2	1	1	1
30	4	3	2	1	1	1
31	4	2	1	1	1	1
32	4	2	2	1	1	1
36	4	2	2	2	2	1
37	4	4	3	2	1	1
Group 2 (1 x sensitised)						
41	4	2	1	1	1	1
43	4	2	1	1	1	1
44	4	2	1	0	0	0
45	4	2	1	1	1	1
46	4	2	1	1	1	1
47	4	2	1	1	1	1
Group 3 (naïve)						
50	1	2	3	4	5	5
51	1	2	2	3	5	5
53	1	2	3	4	5	5
55	1	2	2	4	5	5
56	1	2	3	4	5	5
57	1	2	3	4	5	5

* score 0 = no lesion; 1 = dermatitis in <10% infested auricle; 2 = in 10% - 50%; 3 = in 50% - 75%; 4 = in > 75%; 5 = in >75% and dermatitis in other part of the body

Soon after reinfestation, the sensitised goats became pruritic manifested by restless and flapping their auricles. At 12 hours post infestation, the infested auricle severely swollen and hotter than other parts of the body. The infested auricle was 2 to 3 times as thick as that before infestation and thick exudates were oozed from the swollen auricles (Figure 1a). The swelling, which lasted a few days only, developed into severe pustular dermatitis. Copious exudates, which were likely consisted of serum and inflammatory cells, accumulated and dried out on the surface of the auricle. After a while the dried exudates sloughed off leaving patches of alopecia. At 10 days post infestation, a marked healing process was evident. Numerous small papules and yellowish tan scab or crust either dry or moist were scattered on the surface of the infected auricle, the epidermis was thickened and blood vessels were enlarged (Figure 1 b). By 30 days post infestation, the scales were disappeared but the small papules and alopecia still existed (Figure 1c). The appearance of lesion at 40 days post infestation was not much changes, except the areas of alopecia become reduced because of the hair regrowing. At 50 days post infestation, the area of alopecia disappeared; consequently, the infested auricle apparently healed completely (Figure 1d). However, when the auricle was palpated small papules could still be felt.

In contrast to the sensitised groups, the majority of goats in naïve group did not exhibit grooming behavior after infestation. Severe swelling and exudation were not seen except some goats exhibited mild swelling at the primary site of infestation at 48 hours post infestation. In all animals in this group, small papules could be felt when the infected auricle was palpated. Lesion developed slowly but progressively. At 10 days post infestation, thin crusts were formed on the infested auricle. At 20 days post infestation the crusts become thicker and involved a wider area (Figure 2A). At 30 days, the whole infested auricle affected by the encrustation dermatitis. At 40 days, the whole auricle covered by thick scab or crust and skin in other parts of the body especially shoulder and neck were also affected (Figure 2B). By 50 days, practically skin all over the body involved, the animals was scratched frequently and their condition become poorer and poorer (Figure 2C)

DISCUSSION

The present study clearly shows that goats previously infested with *S. scabiei* developed immunologically mediated resistance against subsequent mite challenge. Naïve goats experimentally infested with the mite developed progressive encrustation dermatitis which affected almost the whole

skin after 7 weeks. On the other hand, when sensitised goats (previously expose to the mite) were infested similarly, they developed only a mild papular dermatitis at the site of infestation after 7 week. The results of this study are generally consistent with previous studies in men sensitised and challenge with *S. scabiei* var. *homini* (MELLANBY, 1944), in rabbits with *S. scabiei* var. *canis* (ARLIAN *et al.*, 1994a,b), in dogs with *S. scabiei* var. *canis* (ARLIAN *et al.*, 1996), and in cattle sensitised and challenge with other species of mite, *Psoroptes ovis* (STROMBERG and FISHER, 1986).

Lesions due to the mite infestation in naïve goats, as observed in this study, are initiated by formation of palpably small papules which are slowly progressing. Skin over the papules is covered by yellow scab and scales which originally thin but become thicker and thicker. In severe lesion, which in this study observed at 7 weeks post infestation, the whole skin thickened and covered with thick scab. Lesions described in these naïve goats are comparable to those observed in goats experimentally infested with *S. scabiei* var. *caprae*, *S. scabiei* var. *cameli* (NAYEL and ABU-SAMRA, 1986) or *S. scabiei* var. *ovis* (ABU-SAMRA *et al.*, 1984). However, in those studies the papules are reported to occur after 1 or 2 weeks, whereas in the present study the papules could be detected at 48 hours post infestation. The clinical and pathological descriptions of caprine scabies derived from the experimental infestation are also comparable with those of natural disease (ABU-SAMRA *et al.*, 1981).

Mite infestation in naïve goats, as observed in the present study and previous studies (ABU-SAMRA *et al.*, 1981, ABU-SAMRA *et al.*, 1984; NAYEL and ABU-SAMRA, 1986), apparently always resulted in severe encrustation dermatitis affecting the whole skin, and no spontaneous recovery has been observed. Inability to spontaneously recover from the mange has also been observed in sarcoptic mange in coyotes (*Canis latrans*) (PENCE *et al.*, 1983). Unlike in goats and coyotes, mite infestation in naïve pigs is not always resulted in severe crusted mange because the rate of spontaneous healing in sarcoptic mange in pigs is reported to be quite high (SHEAHAN, 1974). In human, the scabies is known in two forms: classical scabies and crusted or Norwegian scabies. The classical form which is characterized by papular dermatitis and generalised pruritus is generally self-limiting. Whereas, the crusted scabies which is characterised by thick crust and extremely high burden of mites is usually associated with immunosuppressive condition (KEMP *et al.*, 2002). Because the development of crusted scabies requires specific immunosuppressive condition, the incidence of this type of scabies is very low. The fact that infestation of *S. scabiei* in naïve goats always results in crusted scabies is interested and therefore worth further investigation.



Figure 1. Infestation of sensitised goats with *Sarcoptes scabiei*; A=2 days; B=10 days; C=30 days; D=50 days post infestation



Figure 2. Infestation of native goats with *Sarcoptes scabiei*; A=10 days; B=40 days; C=50 days post infestation

The sensitised goats in this study were older than the naïve goats but their protective immunity against mite challenge was unlikely associated with the older age. When infested for the first time, these goats also did not possess protective immunity. As a matter of fact, age, breed and sex of animals have been shown to be of little or no effect on the course of clinical disease (SHEAHAN, 1974).

Mite infestation in sensitised goats, as observed in this study, provokes severe pruritis and severe oedema at the site of infestation which turn resulted in severe pustular dermatitis within days. Such severe type of host responses which is typical of immediate hypersensitive or allergic reaction did not observed in previous similar studies in human (MELLANBY, 1944), in rabbits (ARLIAN *et al.*, 1994a, 1994b) or in dogs (ARLIAN *et al.*, 1996). The severe reaction observed in the present study could not be entirely attributed to the rich vascularisation of the site of infestation, the auricle. In a previous study; ARLIAN *et al.* (1994a,b) also infested the rabbits with the mite at the auricles but such severe allergic reaction did not occur. The allergic reaction is thought to play a central theme in the immunity against mite challenge. The grooming behaviour of the host due to severe pruritis and severe exudation at the site of infestation, which occur immediately upon the host in contact with the mite, may kill or at least hamper the colonisation of the mites.

Although *S. scabiei* live only in the avascular part of the skin, both humoral and cellular immune responses against the mite antigens are developed (ARLIAN *et al.*, 1994, ARLIAN *et al.*, 1996). Because the mites only live on the avascular part of the skin, the mite antigens must be diffused through the epidermis and stimulate the cell-presenting cells or the Langerhans cells in the dermis. The 'diffusible' antigens are likely to be soluble in nature and secrete or excrete by the mite, not the structural components of the mites.

The most difficult and laborious part in the developing vaccines against multicellular parasites, especially the mite, would be identifying the mite components suitable for the vaccine main components. The antigens responsible for the immune protection in the sensitised animals may be used as the vaccine component. However, immunisation of animals with those antigens may not give a complete protection to the immunised animals. The reason for this is provided from the results of the present study. Firstly, the immunity develops in animals previously suffered from mange could not completely protect the animals from mite challenge. The presence of small papules at the site of infestation at the end or 7 week post challenge in all the sensitised goats may indicates small number of mites are able to overcome the host immunity. These findings are in line with those obtained from previous studies in rabbits (ARLIAN *et al.*, 1994a,b), in dogs

(ARLIAN *et al.*, 1996), and in cattle (STROMBERG and FISHER, 1986). Secondly, the degree of protection in goats that had been sensitised twice was not higher than that in goat sensitised only once. This may suggest that the immunity induced by the diffusible antigen is incompletely protective in nature. In other words, immune responses induced by the antigens are incapable of protecting animals despite the titre of immune responses.

CONCLUSION

Sarcoptes scabies in goats causes crusted type of scabies. Unlike scabies in human or pigs which is frequently self-limiting, scabies in goats is progressive. Although the mites live only on the avascular part of the skin, they are capable of stimulating protective immunity. The immunity is associated with immediate hypersensitivity. The immunity possessed by goats previously infested by the mites, however, could not completely protect the sensitised animals against mite reinfestation.

REFERENCES

- ABU-SAMRA, M.T., S.E. IMBABI and E.S. MAHGOUN. 1981. Mange in domestic animals in the Sudan. *Annals Trop. Med. Parasitol.* 75: 627-637.
- ABU-SAMRA, M.T., K.E.E. IBRAHIM and M.A. AZIS. 1984. Experimental infection of goats with *Sarcoptes scabiei* var. *ovis*. *Annals Trop. Med. Parasitol.* 78: 55-61.
- ARLIAN, L.G., M.S. MORGAN, D.L. VYSZENSKI-MOHER, and B.L. STEMMER. 1994a. *Sarcoptes scabiei*: The circulating antibody response and induced immunity to Scabies. *Exp. Parasitol.* 78: 37-50.
- ARLIAN, L.G., C.M. RAPP, D.L. VYSZENSKI-MOHER, and M.S. MORGAN. 1994b. *Sarcoptes scabiei*: Histopathological changes associated acquisition and expression of host immunity to Scabies. *Exp. Parasitol.* 78: 51-63.
- ARLIAN, L.G., M.S. MORGAN, C.M. RAPP, and D.L. VYSZENSKI-MOHER. 1996. The development of protective immunity in canine scabies. *Vet. Parasitol.* 62: 134-142.
- BROTOWIJOYO, M.D. 1987. Scabies pada hewan dan permasalahannya. *Bulletin FKH UGM.* 7: 1-5.
- DONALD, A.D. 1994. Parasites, animal production and sustainable development. *Vet. Parasitol.* 54: 27-47.
- DORNY, P. T. VAN WYNGAARDEN, J. VERCRUYSSSE, C. SYMEONS, A. JALIA, A. 1994. Survey on the importance of mange in the aetiology of skin lesions in goats in Peninsular Malaysia. *Trop. Anim. Hlth. Prod.* 26: 81-86.
- GABAJ, M.M., W.N. BEESLEY, M.A. AWAN. 1992. A survey on farm animals in Libya. *Ann. Trop. Med. Parasitol.* 86: 537-542.

- KEMP, D.J., S.F. WALTON, P. HARUMAL and B.J. CURRIE. 2002. The scourage of scabies. *Biologist* 49: 19-24.
- MANURUNG, J, BERIAJAYA, dan M. KNOX. 1987. Pengamatan pendahuluan penyakit kudis pada kambing di Kabupaten Pandeglang, Jawa Barat. *Penyakit Hewan* 19: 78-81.
- MANURUNG, J., P. STEVENSON, BERIAJAYA and M.R. KNOX. 1990. Use of Ivermectin to control sarcoptic mange in goats in Indonesia. *Trop. Anim. Health. Prod.* 22: 206-212.
- MELLANBY, K. 1944. The development of symptoms, parasitic infection and immunity in human scabies. *Parasitol.* 35: 197-206.
- Nayel, N.M. and M.T. Abu-Samra. 1986. Experimental infection of the one humped camel (*Camelus dromedarius*) and goats with *Sarcoptes scabiei* var. *cameli* and *S. scabiei* var. *caprae*. *Br. Vet. J.* 142: 264-269.
- PARIJA, B.G., S.C. MISRA, and P.K. SAHOO. 1995. Changing pattern in the epidemiology of caprine mange in Bhubaneswar. *Indian Vet. J.* 72: 536-538.
- PENCE, D.B., L.A. WINDBERG, B.C. PENCE, and R. SPROWLS. 1983. The epizootiology and pathology of sarcoptic mange in coyotes, *Canis latrans*, from South Texas. *J. Parasitol.* 69: 1100-1115.
- SHEAHAN, B.J., 1974. Experimental *Sarcoptes scabiei* infection in pigs: Clinical signs and significance of infection. *Vet. Rec.* 94: 202-209.
- STROMBERG, P.C. and W.F. FISHER. 1986. Dermatopathology and immunity in experimental *Psoroptes ovis* (Acari: Psoroptidae) infestation of naïve and previously exposed Hereford cattle. *Am. J. Vet. Res.* 47: 1551-1560.
- WILLADSEN, P. 1997. Novel vaccines for ectoparasites. *Vet. Parasitol.* 71: 209-222.