Dept. of Vet. Med.,
Faculty of Vet. Med., Cairo Univ.,
Head of Dept. Prof. Dr. A.A. Salem.

# *FURTHER STUDIES ON THE EFFICACY OF THE LOCALLY PREPARED BABESIA EQUI VACCINE ON EQUINE PIROPLASMOSIS COMPARED WITH IMPORTED ONE*

*(With 6 Tables)*

*By*

***A.A. SALEM; SAMIA, A.H.; M.A. EL-SEIFY* and G.H. EL-BATTAWY*****

*(Received at 3/7/1989)*

دراسات متقدمة عن مدى كفاءة لقاح البابيزيا اكواى المحضر محلياً على مرض ملاريا الخيول مقارناً بآخر مستورد

عبد المنعم سالم ، سامية عبد الحميد ، محمود الصيفى ، جمال البطاوى

فى هذه الدراسة تم تحضير لقاح من عترة البابيزيا اكواى وقد أجريت تجارب لإختبار مدى كفاءته على درجة إصابة الفصيلة الخيلية بمرض الملاريا . وقد قورن هذا اللقاح بآخر مستورد من الولايات المتحدة الأمريكية من ناحية تأثير كل منهما على حالة الدم والحالة الإكلينيكية للحيوان . ويتضح من نتائج الدراسات المختلفة أن كلاً من اللقاحين ( المحلى والمستورد ) يعطى حماية للحيوانات المحصنة بنسبة ٦٦ر٦٦٪ على الرغم من أن جرعة التحصين من اللقاح المحلى نصف الجرعة المستخدمة من اللقاح المستورد . و من نتائج التجارب التى أجريت فى هذا البحث نوصى بإستخدام اللقاح المحلى خصوصاً للخيول القيمة وذلك لقلة التكاليف وتوفيراً لتكاليف الإستيراد وحيث أنه سيكون فى المتناول عند طلب إستخدامه .

## *SUMMARY*

In this study a killed vaccine from a locally isolated Babesia equi strain was prepared and subjected to different studies. The efficacy of this vaccine was compared with an imported killed B. equi vaccine prepared in U.S.A.

The results revealed a slight clinical changes due to vaccination by both local and imported vaccines and challenge by both infected blood & ticks. It was concluded that both vaccines were nearly equal in immunological properties and protecting donkeys, inspite of the component of the local vaccine in half that of the imported one, as confirmed by clinical, haematological and seriological investigations.

* Dept. of Parasitology, Faculty of Vet. Med., Beni-Suef.
** Dept. of Vet. Med., Faculty of Vet. Med., Cairo Univ.

## INTRODUCTION

Equines play an important role in the economic Nation as it is used for breeding and exportation. In Egypt, equines are infected by several diseases of which babesiosis is one of the important enzootic diseases in several areas. In these areas although horses are premunized against piroplasmosis and act as reservoir of infection, yet this immunity may break down under adverse condition and such animals become clinically infected (THEILER, 1906).

Concerning the work done on the equine premunization against B. equi, SMITH, et al. (1893) suggested the first method for premunized healthy animals against piroplasmosis by injecting them subcutaneously with blood of patent carriers. THEILER (1908) attenuated Babesia without interfering with their immunized properties after four passages in donkey foal for purposes of vaccination. Also NEITZ (1956); MAURER (1962) and SERGENT (1963) reported that, equines can protected for a period ranged between 1 & 5 years by superinfection by B. equi parasites. SINGH, et al. (1981) immunized donkeys against B. equi infection using killed prepared from infected erythrocytes or infected plasma collected during the peak of parasitaemia from a splenectomized donkey and they were found that all vaccinated donkeys were protected.

SALEM, et al. (1986) studied vaccination of donkeys with killed B. equi vaccine resulted in 66.66% immunity as confirmed by challenge using nymphs of Rhipicephalus turanicus ticks 63 days after vaccination. It was found that of great importance to use the vaccines in the control of equine piroplasmosis, therefore, it was necessary to carry out further investigation on this problem.

## MATERIAL and METHODS

### I - Animals:

Fourteen donkeys of about 10-12 months old, were used to study the immune response of Babesia equi vaccines. Seven animals were employed for testing the local prepared vaccine, whereas the other 7 were for testing American B. equi one. All these animals were approved to be B. equi negative.

### II - Vaccines:

**1. Preparation:**

**a)** Imported Babesia equi vaccine from U.S.A.: A killed vaccine supplied in lyophelized ampoles contained $1x10^6$ parasitic fraction stored at - 8 C and obtained from protozology Department U S D A, Beltsville, Myrland, USA.

**b)** Locally prepared Babesia equi vaccine, which was prepared as following according to the method described by RISTIC & SIBINOVIC (1964) with a modification of adding special white mineral oil-Copetrole WM2 as adjuvant:

* Latent Babesia equi infected donkey of 12 month splenectomized.
* Rectal temperature was recorded and blood films were examined daily.
* When the parasitaemina attained 30%, the donkey blood was aseptically collected in an equal volume of sterile Alsever's solution.
* Three washing of the erythrocytes were applied by centrifugation at 1,5000 k.p.m. after successive suspension from the packed erythrocytes was prepared by adding three volumes of packed erythrocytes.
* The suspension was twice sonically oscillated in continuous flow ultrasonicator with a current out put of 4.5 ampers and a lysate flow of 50 ml/min.
* The oscillated material was sedimented inrefrigerated centrifuge at 3,300 r.p.m./30 min.
* To each 100 ml of the supernatent lysate, 0.5 of protamine sulpate dissolved in 10 ml of distilled water was added.
* The mixture was then left for 2 hours at 4°C and centrifuged at 3.300/30.
* Two volumes of phosphate-buffered physiological salt solution PH. 9.0 were added to each volume of preciptate.
* Afterwards, the mixture was homogenized with Brock glass grinder and stored for at least 48 hours at-65°C.
* The precipitate was then rehomogenized with the same grinder and centrifuged at 12.100 r.p.m./30, the supernatent fluid was called the precipitinogen.
* The precipitinogen was mixed in an equal volume of oil adjuvant by syring technique and stored at-65°C in vials containing 4 ml. Each 1 ml contained $0.6x10^6$ B. equi fraction. Thimersoi was added in a concentration of 1:10000 when stored for more than 3 weeks.

**2. Vaccination of the animals:**

The animals used were divided into 2 groups wach one contained 7 B. equi free donkeys.

* First group subdivided into 4 donkeys (no: 1, 2, 3 & 4) vaccinated by locally prepared vaccine by a dose of 4 ml (each 1 ml contained $2.4x10^6$ killed B. equi fraction) I.m. in the neck region, and 3 animals (no: 5, 6 & 7) were left as non-vaccinated.
* Second group also subdivided into 4 donkeys (no: 8, 9, 10 & 11) vaccinated by U.S.A. obtained vaccine by a done of 2 ml (each 1 ml contained $1x10^7$ killed B. equi frection S/C in the neck region and 3 animals (no: 12, 13 & 14) were left as non-vaccinated.

**III- Challenge of vaccinated and non-vaccinated (controi) animals:**

The challenge of vaccinated and control donkeys was done 10 weeks after vaccination by 2 methods:

i) By using B. equi infected blood:
Each animal inoculated by 100 ml heparinized blood infected by B. equi obtained from infected donkey showing 30-35% parasitaemia.

ii) And by using B. equi infected Rhipicephalus turanicus ticks
Adults (males & females) of R.turanicus ticks which were bred on B. equi infected donkeys were used. The ticks were applied in ear cage on one ear of each donkey according to the method of ROBY & ANTHONY (1963).

The challenge occurred for 5 animals 3 vaccinated and 2 non-vaccinated in each group. The challenge tacked place using B. equi infected blood for 2 animal (vaccinated 8 non-vaccinated of both 2 groups) and infected Rhipicephalus turanicus ticks for 2 vaccinated and 1 non-vaccinated animals among 1st & 2nd groups. All vaccinated and control animals were investigated for any clinical abnermalities and weekly subjected to the following studies:

A- Parasitological examination of blood films according to the method described by SHUTT (1962).

B- Blood pictures including determination of:
1- Erythrocytic count According to the method described by JOHN (1977).
2- Haemoglobin content According to the method described by SCHALM (1961).
3- Total and differential leukodytic counts (neutrophils %; Eosinophils %; Basophils %; Lymphocytes % and Monocytes %) according to the method described by JOHN (1977).

C- Serological studies including:
1- Complement fixation test (C F T) according to the method describd by TENTER and FRIEDHOFT (1986).
2- Fossive haemaglutination test (P H A) according to the method described by GOTY (1982).

## *RESULTS*

The results of parasitological and clinical investigations as displayed in Table (1) revealed that donkeys vaccinated with local B. equi vaccine did not show any changes in the body temperature after vaccination except one animal where it was elevated to 39.3°C for one week post-vaccination, then the temperature returned to normal without any medical interference. Also blood films examination revealed the absence of B. equi for 3 weeks post-vaccination. After challenge with infected blood, the animals did not show any clinical manifestations and the blood remained B. equi free for 8 weeks post-challenge. Otherwise, the animal was kept Babesia free for 18 weeks. By the same manner one animal of those vaccinated and challenged infected Rhipicephalus turanicus ticks does not show any clinical or parasitological manifestations.

On the other hand the other animal which was vaccinated and challenged by the infected ticks showed B. equi in the blood films from 2nd week post-challenge. In non-vaccinated and challenged by both infected blood and ticks the Babesia parasite appeared in the blood of first animal in the 2nd week post-challenge for 5 weeks then disappeared and in the 1st week post-challenge till the end of the experiment.

Similarly, the clinical and blood film examinations of donkeys vaccinated by American strain of B. equi vaccine, the results as shown in table (2) revealed that, the vaccinated animals challenged with both infected blood and ticks showed infected R.B.Cs. within 2 weeks post-challenge with elevation in body temperature.

The results of blood picture studies indicated (table 3) increase in total erythrocytic count, haemoglobin content, total leukocytic count and basophils of all vaccinated animals by locally prepared B. equi vaccine. While those given the American strain showed (table 4) decrease in total leukocytic count.

Concerning the serological studies of vaccinated and challenged donkeys (tables 5 & 6) indicated that the vaccinated animals by local adjuvant B. equi vaccine showed the titer of complement fixation test (C F T) ranged between 1:20 and 1:320 and that of passive haemagglutintion test (P H A) ranged between 1:2 and 1:64. Then the titer of C F T declined to disappear to zero after 5 & 6 weeks post-challenge, while the P H A test indicated that the titers remained constant in some vaccinated animals till the end of the experiment and decreased to the following dilution in anther. Also the vaccinated animals by American strain of B. equi vaccine showed that the vaccinated animals were negative to C F T & P H A before experimentation and after vaccination both techniques were positive, while the non-vaccinated control animals showed negative results till end of the experiment (21 weeks).

## *DISCUSSION*

The present investigation was directed to perform further studies for immunizing animals against babesiosis by locally prepared Babesia equi vaccine and compare the efficacy of this vaccine with that of B. equi vaccine imported from U.S.A. on donkeys.

In the study using the local B. equi vaccine resulted in mild reaction at the site of inoculation (slight swelling and hotness) in all vaccinated donkeys, and slight elevation of body temperature (39.3°C) in one animal for one week only. This vaccinal reaction may be attributed to the lower absorbability of the oily portion of the vaccine which acts as foreign material or may be due to delayed cutaneous hypersensitivity of vaccinated animals as reported by SMITH, et al. (1979) and PRASAD and BANERJEE (1985). On the other hand the results of using American B. equi vaccine showed no local post-vaccinal reaction at the site of inoculationin donkeys, but elevation of body temperature (39.5°C) during the 1st week post-vaccination. The abscence of local reaction might be attributed to that this vaccine was reconstituted in distalled water, whereas

post-vaccinal temperature may be due to hypersensitivity of the animal body to the foreign portion of this vaccine.

Vaccinated donkeys were exposed to challenge and the results revealed a slight elevation of body temperature during the 2nd & 3rd weeks then declined to normal without any treatment. On the other hand, body temperature of control non-vaccinated challenged donkeys reached 39.1°C during the 2nd week post-challenge, then declined to normal after adminestration of Imizol at a dose rate of 2 ml/100 kg.B.W. in 2 doses at 72 hours intervals. This higher temperature of control animals was attributed to parasitaemia as proved by examination of blood films, which could be overcomed by treatment. Examinations of stained blood films revealed Babesia organisms in one of vaccinated donkeys after challenge through out the experimental period, this matter was not met in animals challenged by infected ticks which were more virulant. These agred with that obtained by DALGLIESH (1968), SMITH, et al. (1979), KUTTER and JOHNSON (1980), DEVOS, et al. (1982), KUTTER, et al. (1982), GOODGER, et al. (1985). PIPANO, et al. (1985) and WRIGHT, et al. (1985) who reported a higher body temperature among control non-vaccinated donkeys than among vaccinated animals, and was mostly attributed to parasitaemia. Also, the challenge of the animals which were vaccinated by American B. equi strain produced an elevation in the body temperature ranged 38.9-39.9°C. This fever may be attributed to parasitaeria which was proved by blood film examination.

Haematological investigation of donkeys inoculated by local B. equi vaccine revealed an increase in total erythrocytic count, haemoglobin content, total leukocytic count and basophils of all animals, with 3 out of 4 donkeys increase in neutrophils; and decrease in eosinophils, and lymphocytes in 3 out of 4 animals post-vaccination. These results agred with those of NETTO and RIBERIO (1955); SALEM, et al. (1986) and TRUMAN and Mc LENEN (1987). On other hand the obtained results were not in full agreement with TIMMS, et al. (1984) who reported only an increase in lymphocytes post-vaccination. While haematological investigation of donkeys inoculated by American B. equi strain revealed an increase of total erythrocytic count, haemoglobin content and monocytes of 2 and of 4 animals post-vaccination. On the other hand there were a decrease in total leukocytic count in all animals, and a decrease in basophils in 3 out of 4 donkeys and also a decrease in lymphocytes in 2 animals.

After challenge of animals vaccinated by locally prepared vaccine, there was a decrease in total erythrocytic count, haemoglobin content, total leukocytic count and basophils of all vaccinated animals with 2 out of 3 donkeys decrease in neutrophils and monocytes, and increase in eosinophils of all animals and the lymphocytes increased in 2 of them. These agred with that of MALHERB (1956); ROJAS LISCANO (1960); ROBERTS, et al. (1962); CARPIO (1972); ALLEN, et al. (1975); RUDOLPH, et al. (1975); RAMADAN and BAUER (1978); FUTTER, et al. (1980); NAFIE (1980); HOSNEY, et al. (1982) and SALEM, et al. (1986) who reported a decrease in neutrophils of animals post-vaccination and disagred with ROJAS LISCANO (1960); RANDY and MISHIRA (1977); RAI, et al. (1982) who reported that lymphocytes decreasedin animals post-infection.

The challenge of animals that vaccinated by American killed B. equi vaccine resulted in a decrease in total erythrocutic count and eosinophils in 2 out of 3 donkeys, but the basophils decreased in all animals. On the other hand the increased of lymphocytes in all animals post-challenge can be attributed to activity of immune system.

Concerning the serological response for the locally prepared B. equi vaccine by using complement fixation and passive haemagglutination tests. The complement fixation test showed 1:20 - 1:80 positive titer at the 1st week and 1:320 at the 7th week post-vaccination. This titer decreased to 1:80 at 1st week post-challenge and disappeared at 5th and 6th weeks post-challenge. Also the using of the passive haemagglutination test on donkeys vaccinated by the local vaccine resulted in 1:2-1:8 positive titer at the 2nd week then elevated till 1:32-1:64. This titer was declined to 1:16-1.32 in animals during the 1st week post-challenge and remained constant till the end of experiment. The obtained results agred with those obtained by SIBINOVIC, et al. (1969); GOODGER and MAHONEY (1974); MAHONEY, et al. (1979); ABD EL-HADY (1981); SINGH and GAUTAM (1981) and GOTY (1982) who reported that the complement fixation test was sensitive one specially in early infection. Using the C F T & P H A on donkeys vaccinated by American vaccine revealed detectable C F titer (1:10-1:80) after vaccination and (1:20-1:40) after challenge. Also the passive haemagglutination titer was detectable at the 1st & 2nd week post-vaccination, ther declined at the 1st week post-challenge.

It was concluded from the results of this study that although vaccine prepared from the locally isolated Babesia organisms has half the dose of that imported one, yet, the two vaccines gave equal immunizing properties.

Therefore, the local prepared vaccine prefered than the imported one due to the higher immunogenicity, the less cost and less time in obtaining such vaccine. It is also advised to use this local vaccine for immunizing of expensive animals to raise their resistance against infection and to maintain babesiosis free animals from the clinical point of view.

## *REFERENCES*

Abd El-Hady, S.M.R. (1981): The incidence of Babesia equi in horses and donkeys by the haemagglutination test. Thesis of M.V.Sc. for Faculty of Veterinary Medicine, Cairo University, Egypt.

Allen, P.C.; Frerichs, W.M. and Holbrook, A.A. (1975): Experimental acute B.caballi infection. I: Red blood cell dynamics. Experimental parasitology 73 (1), 67-77.

Carpio, J. (1972): First report (in peru) of equine babesiosis due to Babesia equi. Revista de investigations pecuarias, Peru, 1 (2), 177-183.

Dalgliesh, R.J. (1968): Field observation on B.argentina vaccination in Queensland. Aust. Vet. J., 44, 103-104.

De vos, A.J.; Combrink, M.P. and Ressenger, R. (1982): B.begemina vaccine: composition of the efficacy and safety of australian and south african strains under experimental conditions in south africa. Onderstepoort J. Vet. Res., 49, 155-158.

Futter, G.J.; Belonje, P.C. and Berg, A. Ven Den (1980): Studies of feline babesiosis, 3. Haematologicla findings. Journal South African Vet. Assoc., 51 (4), 271-280.

Goodger, B.V. and Mahoney, D.F. (1974): Evalution by the passive haemagglutination test for diagnosis of B.argentina infection in cattle. Aust. Vet. J., 50 (6), 246-249.

Goodger, B.V.; Wright, I.G.; Waltisbuhi, D.J. and Mirre, G.B. (1985): B.bovis, successful vaccination against homologous Challenge in splenectomized calves using a fraction of haemagglutination antigen.

Goty, F. (1982): Sutability of ELISA, IFAT, IHA and CFT for detecting B.equi infection. Inaugural Dissertation, Ludwing-Maximilians. Universitate, Munchen, 39 pp.

Hosney, Z.; Hafez, M.A. and Edries, M. (1982): On equine babesiosis: Significance of blood cytological examination of horses and donkeys. Assiut Vet. Med. J., 9 (17), 34-37.

John, B. Mail (1977): Laboratory Medicine haematology. 5th Ed. C.V. Mosly Co.

Kutter, K.L. and Johnson, L.W. (1980): Immunization of cattle with a B.bigemina antigen in Am. Freund's complete adjuvant. J. Vet. Res., 41 (4), 536-538.

Kutter, K.K.; Levy, M.C. and Ristic, M. (1982): Efficacy of non-viable culture-derived B.bovis vaccine. Am. J. Vet. Res., 43 (2), 281-284.

Mahoney, D.F.; Wright, I.G. and Goodger, B.V. (1979): Immunity in cattle to B.bovis after single infection with parasites of various orign. Aust. Vet. J., 55(1), 10-12.

Malherbe, W.D. (1956): The manifestation and diagnosis of Babesia infections. Ann. N.Y. Acd. Sci., 64, 128-146.

Nafie, T.S.A. (1980): Effect of blood parasitic infestation - Equine piroplasmosis on the picture of some trace elements in equines. Thesis, M.V.Sc., Faculty of Vet. Med., Assiut Univ., Egypt.

Neitz, N.O. (1956): Classification, Transmission and Biology of piroplasma of Domestic Animals. Ann. New York Acad. Sci., 64, 56-111.

Netto, A.R. and Riberio, I.F. (1955): Changes in the haemoglobin, plasma protein and haematocrit Values during premunization of cattle against piroplasmosis and anaplasmosis. Rev., Fac. Med. Vet., S. pau; o, 5, 317-334.

Pandy, N.N. and Mishira, S.S. (1977): Studies on the haematological changes and blood glucose level in B.begemina in indigenous cow calves. Indian Vet. J., 54 (11), 880-883.

Pipano, E.; Krigel, Y.; Markovics. A.; Rubinstein, E. and Frank, M. (1985): Mitigation of the response of friesian calves to live B.bovis vaccine by treatment with long acting oxytetracycline. The Vet. Rec., 10, 413-414.

Prasad, K.D. and Banerjee, D.P. (1985): Immune response in cattle vaccination with killed and irradiated B.bigemina vaccines. Indian J. of Vet. Med., 5 (2), 88-92.

Rai, R.B.; Dhirendra, S. and Singh, N.P. (1982): Clinico-pathological studies on boving babesiosis. Haryana Veterinarian, 21 (1), 11-16.

Ramadan, P. and Bauer, M. (1978): Blood picture in babesiosis in dog. Veterinarski Archive, 48 (5), 251-256.

Ristic, M. and Sibinovic, S. (1964): Equine babesiosis: Diagnosis by precipitation in Gel and a one step fluorescent antibody inhibition test. Am. J. Vet.Res.,25, 1519-1526.

Roberts, E.D.; Morehouse, L.G.; Gainer, S.H. and Danial, H.A. (1962): Equine piroplasmosis. J. Am. Vet. Med. Assoc., 141, 1323-1329.

Roby, T.O. and Anthony, D.W. (1963): Transmission of Equine piroplasmosis by Dermacentor nitens (Neuman). J. Am. Vet. Med. Assoc., 142 (7), 768-769.

Rojas Liscano, D.R. (1960): Changes in the blood picture during premunization of cattle against protozoal disease. Rev. Med. Vet. Parasit., Maracay, 18, 193-194.

Rudolph, W.; Corea, J.; Zurita, L. and Manely, W. (1975): Equine piroplasmosis: leukocytic response to B.equi (Laveran, 1910) infection in Chile. British Vet. J., 131 (5), 601-609.

Salem, A.A.; El-Battawy, G.; El-Seify, M.A.; Selim, M.K. and Hosney, Z. (1986): Preliminary investigation on haematological and biochemical picture of blood of premunized donkeys against B.equi Assiut Vet. Med. J., 16 (31), 147-157.

Schalm, O.W. (1961): Veterinary Haematology. 1st Ed. Lea and Febiger, Phladelphia, United State of America.

Sergent, E. (1963): Latent infection and premunition. Some defenitions of microbiology and immunology. Granham, Pierce, and Roitt Immunity to protozoa, 39-47. (Black well scientific piblications, Oxford, 1963).

Shutt, P.G. (1962): Special article: the staning of malaria parasites. Transacions of the Royal Society of Tropical Medicine & Hygeine, 60 (3), 412-419.

Sibinovic, S.; Sibinovic, H. and Ristic, M. (1969): Equine babesiosis: Diagnosis by bentonite agglutination and passive haemagglutination tests. Am. J. Vet. Res., 30 (5), 691-695.

Singh, B. and Gautam, O.P. (1981): A comparison of serological tests for the diagnosis of equine babesiosis. Indian J. of Vet. Med., 1 (1), 44-50.

Singh, B.; Gautam, O.P. and Banerjee, D.P. (1981): Immunization of donkeys against B.equi infection using killed vaccine. Veterinary parasitology, 8 (2), 133-136.

Smith, F.; Kilbron, F.L. and Schroeder, W.F. (1893): Additional observation in texas cattle fever. Bureu of animal Industry, U.S.Dep. of Agric., Bull. 3, 67-72.

Smith, R.D.; Carpenter, J.; Cabera, A.; Gravel, S.M.; Erp, E.E.; Osorno, M. and Ristic, M. (1979): Bovine babesiosis: vaccination against tick-Borne challenge exposure with culture-derived B.bovis immunogens. Am. Vet. Res., 40 (2), 1678-1682.

Tenter, A.M. and Friedhoff, K.T. (1986): Serodiagnosis of experimental and natural B.equi and B.caballi infections. Vet. parasitology, 20 (1/3), 49-60.

Theiler, A. (1906): Further notes on piroplasmosis of the horse, mule and donkey. Rep. Gov. Vet. Bact. Transv., pp. 94-106.

Theiler, A. (1908): Continuation of experiments for inoculation against piroplasmosis. Rep. Gov. Vet. Bact. Transv., pp. 13-23.

Timms., P.; Stewart, N.P.; Rodwell, B.J. and Barry, D.N. (1984): Immune responses of cattle following vaccination with living and non-living B.bovis antigens. Vet. parasitology, 16 (3/4), 243-251.

Trueman, K.F. and Mc Lennan, M.W. (1987): Bovine abortion due to prenatal B.bovis infection. Aust. Vet. J., 64 (2), 63.

Wright, I.G.; Mirre, G.B.; Rode-Bramanis, K.; Chamberlain, M.; Goodger, B.V. and Waltisbuhl, D.J. (1985): Protective vaccination against virulent B.bovis with a low-molecular-weight antigen. Infection and Immunity, 48 (1), 109-113.

Table (1)

Results of clinical and blood film exaninations of donkeys vaccinated by oil adjuvant Babesia equi locally prepared vaccine

| parameters of animal / weeks | | vaccinated donkeys | | | | | | | | Non-vaccinated control donkeys | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | challenged by infected | | | | | | Non challenged control | | challenged by infected | | | | Non challenged | |
| | | blood | | ticks | | | | | | blood | | ticks | | | |
| | | 1 | | 2 | | 3 | | 4 | | 5 | | 6 | | 7 | |
| | | *Temp. °C | *Bl.f. | Temp. °C | Bl.f. | Temp. °C | Bl.f. | Temp. °C | Bl.f. | Temp. °C | Bl.f. | Temp. °C | Bl.f. | Temp. °C | Bl.f. |
| pre-vaccination | 1 | 37.2 | -ve | 37.4 | -ve | 37.6 | -ve | 37.6 | -ve | 37.8 | -ve | 37.5 | -ve | 37.4 | -ve |
| | 2 | 37.4 | -ve | 37.2 | -ve | 37.2 | -ve | 37.6 | -ve | 37.8 | -ve | 37.5 | -ve | 37.5 | -ve |
| | 3 | 37.6 | -ve | 37.6 | -ve | 37.4 | -ve | 37.2 | -ve | 37.6 | -ve | 37.2 | -ve | 37.6 | -ve |
| post-vaccination | 1 | 38.0 | -ve | 38.0 | -ve | 39.3 | -ve | 37.0 | -ve | 37.9 | -ve | 37.0 | -ve | 37.5 | -ve |
| | 2 | 38.7 | -ve | 38.1 | -ve | 38.3 | -ve | 37.3 | -ve | 38.1 | -ve | 37.8 | -ve | 38.2 | -ve |
| | 3 | 38.7 | -ve | 37.5 | -ve | 38.3 | -ve | 38.3 | -ve | 38.5 | -ve | 38.5 | -ve | 38.2 | -ve |
| | 4 | 38.2 | -ve | 37.8 | -ve | 37.6 | -ve | 37.0 | -ve | 38.0 | -ve | 38.5 | -ve | 37.0 | -ve |
| | 5 | 38.2 | -ve | 37.2 | -ve | 37.5 | -ve | 37.7 | -ve | 38.2 | -ve | 38.0 | -ve | 37.5 | -ve |
| | 6 | 37.6 | -ve | 37.5 | -ve | 37.2 | -ve | 37.5 | -ve | 37.4 | -ve | 37.8 | -ve | 37.5 | -ve |
| | 7 | 37.8 | -ve | 37.6 | -ve | 37.7 | -ve | 37.3 | -ve | 37.9 | -ve | 38.5 | -ve | 37.0 | -ve |
| | 8 | 37.5 | -ve | 37.5 | -ve | 37.6 | -ve | 38.2 | -ve | 37.8 | -ve | 38.5 | -ve | 37.8 | -ve |
| | 9 | 37.7 | -ve | 37.0 | -ve | 37.5 | -ve | 38.4 | -ve | 37.8 | -ve | 37.4 | -ve | 37.2 | -ve |
| | 10 | 37.6 | -ve | 37.5 | -ve | 37.5 | -ve | 38.4 | -ve | 37.8 | -ve | 38.5 | -ve | 37.8 | -ve |
| post-challenge | 1 | 37.2 | -ve | 37.4 | -ve | 37.0 | -ve | 37.9 | -ve | 38.9 | -ve | 38.1 | +ve | 37.5 | -ve |
| | 2 | 38.6 | -ve | 38.5 | +ve | 38.5 | -ve | 38.4 | -ve | 39.1 | +ve | 39.1 | +ve | 37.5 | -ve |
| | 3 | 37.8 | -ve | 37.5 | +ve | 37.5 | -ve | 38.2 | -ve | 38.5 | +ve | 38.7 | +ve | 37.5 | -ve |
| | 4 | 37.6 | -ve | 37.7 | +ve | 37.5 | -ve | 38.0 | -ve | 38.7 | +ve | 38.0 | +ve | 37.0 | -ve |
| | 5 | 37.0 | -ve | 37.0 | +ve | 37.5 | -ve | 38.3 | -ve | 38.5 | +ve | 38.4 | +ve | 37.1 | -ve |
| | 6 | 37.7 | -ve | 37.8 | +ve | 37.5 | -ve | 38.0 | -ve | 38.3 | +ve | 38.3 | +ve | 37.2 | -ve |
| | 7 | 37.6 | -ve | 38.2 | +ve | 38.1 | -ve | 38.0 | -ve | 38.3 | -ve | 37.9 | +ve | 37.5 | -ve |
| | 8 | 37.7 | -ve | 38.2 | +ve | 38.0 | -ve | 38.1 | -ve | 38.2 | -ve | 38.1 | +ve | 37.5 | -ve |

* Temp. = Temperature  Bl.f. = Blood films

N.B. All vaccinated donkeys showed mild local reaction only at the site of injection including mild swelling & hotness

Table (2)

Results of clinical and blood film examinations of donkeys vaccinated by killed american Babesia equi vaccine

| parameters of animal / weeks | | vaccinated donkeys | | | | | | | | Non-vaccinated control donkeys | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | challenged by infected | | | | | | Non challenged control | | challenged by infected | | | | Non challenged | |
| | | blood | | ticks | | | | | | blood | | ticks | | | |
| | | 8 | | 9 | | 10 | | 11 | | 12 | | 13 | | 14 | |
| | | *Temp. °C | *Bl.f. | Temp. °C | Bl.f. | Temp. °C | Bl.f. | Temp. °C | Bl.f. | Temp. °C | Bl.f. | Temp. °C | Bl.f. | Temp. °C | Bl.f. |
| pre-vaccination | 1 | 37.7 | -ve | 38.7 | -ve | 37.7 | -ve | 37.6 | -ve | 37.8 | -ve | 37.5 | -ve | 37.4 | -ve |
| | 2 | 37.8 | -ve | 37.8 | -ve | 38.3 | -ve | 37.6 | -ve | 37.8 | -ve | 37.5 | -ve | 37.5 | -ve |
| | 3 | 37.9 | -ve | 37.0 | -ve | 37.0 | -ve | 37.2 | -ve | 37.6 | -ve | 37.2 | -ve | 37.6 | -ve |
| post-vaccination | 1 | 37.2 | -ve | 37.0 | -ve | 39.5 | -ve | 37.0 | -ve | 37.9 | -ve | 37.0 | -ve | 37.5 | -ve |
| | 2 | 37.9 | -ve | 37.8 | -ve | 38.9 | -ve | 37.3 | -ve | 38.1 | -ve | 37.8 | -ve | 38.2 | -ve |
| | 3 | 37.7 | -ve | 37.4 | -ve | 38.7 | -ve | 38.3 | -ve | 38.5 | -ve | 38.5 | -ve | 38.2 | -ve |
| | 4 | 38.0 | -ve | 37.0 | -ve | 38.5 | -ve | 37.0 | -ve | 38.0 | -ve | 38.5 | -ve | 37.0 | -ve |
| | 5 | 38.2 | -ve | 38.2 | -ve | 38.5 | -ve | 37.7 | -ve | 38.2 | -ve | 38.0 | -ve | 37.5 | -ve |
| | 6 | 38.0 | -ve | 37.6 | -ve | 38.5 | -ve | 37.5 | -ve | 37.4 | -ve | 37.8 | -ve | 37.5 | -ve |
| | 7 | 38.4 | -ve | 37.9 | -ve | 38.0 | -ve | 37.3 | -ve | 37.9 | -ve | 38.5 | -ve | 37.0 | -ve |
| | 8 | 37.8 | -ve | 37.9 | -ve | 38.3 | -ve | 38.2 | -ve | 37.8 | -ve | 38.8 | -ve | 37.8 | -ve |
| | 9 | 38.3 | -ve | 38.4 | -ve | 38.7 | -ve | 38.4 | -ve | 37.8 | -ve | 37.4 | -ve | 37.2 | -ve |
| | 10 | 38.4 | -ve | 38.4 | -ve | 38.4 | -ve | 38.4 | -ve | 37.8 | -ve | 38.5 | -ve | 37.8 | -ve |
| post-challenge | 1 | 38.3 | -ve | 38.0 | -ve | 38.0 | -ve | 37.9 | -ve | 38.9 | -ve | 38.1 | +ve | 37.5 | -ve |
| | 2 | 39.9 | +ve | 39.5 | +ve | 38.8 | +ve | 38.4 | -ve | 39.1 | +ve | 39.1 | +ve | 37.5 | -ve |
| | 3 | 38.8 | +ve | 39.0 | +ve | 37.8 | +ve | 38.2 | -ve | 38.7 | +ve | 38.5 | +ve | 37.5 | -ve |
| | 4 | 38.7 | +ve | 38.8 | +ve | 38.5 | +ve | 38.0 | -ve | 38.7 | +ve | 38.0 | +ve | 37.0 | -ve |
| | 5 | 38.0 | -ve | 38.8 | +ve | 38.3 | -ve | 38.3 | -ve | 38.5 | +ve | 38.4 | +ve | 37.1 | -ve |
| | 6 | 37.9 | -ve | 38.1 | +ve | 38.4 | -ve | 38.0 | -ve | 38.3 | +ve | 38.3 | +ve | 37.2 | -ve |
| | 7 | 37.9 | -ve | 37.2 | +ve | 38.4 | -ve | 38.0 | -ve | 38.3 | -ve | 37.9 | +ve | 37.5 | -ve |
| | 8 | 37.6 | -ve | 38.2 | +ve | 38.5 | -ve | 38.1 | -ve | 38.2 | -ve | 38.1 | +ve | 37.5 | -ve |

* Temp. = Temperature  Bl.f. = Blood films

N.B. All vaccinated donkeys showed no local reaction at the site of injection

Table (3)

Results of blood picture in donkeys vaccinated by oil adjuvant Babesia equi vaccine

| parameters / Blood picture / Animals | | | | Total erythrocytic Count | Haemoglobin content gm | Haemoglobin content % | Total leukocytic Count | Differential leukocytic count: Neutrophils % | Eosinophils % | basophils % | Lymphocytes % | Monocytes % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3 weeks pre-vaccination | | | 1 | 04.647 00.262± | 58.000 00.471± | 09.417 00.068± | 10.383 00.496± | 35.667 01.440± | 03.00 00.817± | 00.000 00.000 | 58.676 02.326± | 01.667 00.272± |
| | | | 2 | 05.093 00.201± | 63.000 00.471± | 10.083 00.118± | 16.867 02.478± | 41.000 02.450± | 06.333 01.407± | 00.333 00.272 | 50.000 03.259± | 01.667 00.519± |
| | | | 3 | 04.633 00.486± | 65.330 01.440± | 10.250 01.087± | 12.367 02.284± | 31.667 01.963± | 06.667 02.126± | 00.000 00.000 | 58.200 03.300± | 03.667 00.296± |
| | | | 4 | 04.360 00.171± | 55.000 | 09.000 | 12.067 00.566± | 35.670 03.070± | 01.330 00.270± | 04.670 00.270± | 56.670 02.600± | 01.670 00.270± |
| | | | 5 | 04.640 00.209± | 64.000 01.700± | 10.330 00.250± | 17.950 01.059± | 39.670 03.600± | 00.330 00.270± | 03.670 00.720 | 53.670 03.660± | 01.330 00.270± |
| | | | 6 | 06.350 00.307± | 69.670 00.544± | 11.170 00.140± | 19.217 02.784± | 41.330 06.330± | 01.330 00.270± | 01.000 00.470 | 56.000 06.480± | 01.330 00.270± |
| | | | 7 | 04.983 00.321± | 68.667 00.544± | 10.917 00.136± | 14.933 01.184± | 33.667 05.504± | 04.667 02.288± | 00.000 00.000 | 56.330 08.450± | 02.000 00.817± |
| 10 weeks post-vaccination | vaccinated donkeys | | 1 | 04.861 00.250± | 63.800 01.190± | 10.250 00.190± | 14.595 01.154± | 40.600 02.822± | 02.300 00.247± | 00.500 00.255 | 53.700 02.864± | 01.700 00.302± |
| | | | 2 | 05.112 00.247± | 65.700 00.011± | 10.575 00.146± | 16.870 01.918± | 33.700 02.436± | 04.500 00.861± | 01.200 00.571 | 27.200 02.378± | 02.300 00.247± |
| | | | 3 | 05.087 00.145± | 66.800 01.690± | 10.700 00.252± | 14.065 01.012± | 40.300 04.579± | 02.700 00.376± | 00.800 00.465 | 53.900 02.421± | 02.200 00.310± |
| | | | 4 | 05.276 00.174± | 57.500 00.820± | 09.325 00.142± | 11.530 00.442± | 27.700 03.067± | 06.600 01.401± | 04.600 00.897 | 51.500 08.155± | 01.600 01.200± |
| | Non-vaccinated donkeys | | 5 | 05.746 00.197± | 57.300 01.386± | 09.275 00.208± | 13.190 00.654± | 30.500 02.160± | 03.300 00.722± | 00.800 00.341 | 64.900 02.674± | 00.500 00.158± |
| | | | 6 | 06.158 00.273± | 63.200 02.230± | 10.200 00.346 | 13.555 00.771± | 37.800 02.630± | 03.500 01.177± | 01.500 00.765 | 56.000 02.847± | 00.800 00.276± |
| | | | 7 | 05.489 00.141± | 77.100 02.758± | 12.375 00.181± | 17.400 00.490± | 35.000 01.490± | 03.800 00.660± | 00.500 00.381 | 60.700 02.404± | 01.900 00.411± |
| 8 weeks post-challenge | challenged by infected | blood | 1 | 04.260 00.134± | 63.875 00.389± | 10.531 00.082± | 12.819 00.655± | 43.375 02.292± | 04.500 00.771± | 00.125 00.117 | 50.125 03.370± | 02.125 00.328± |
| | | ticks | 2 | 04.304 00.143± | 65.250 00.125± | 10.496 00.112± | 14.844 00.996± | 27.375 02.622± | 06.250 01.272± | 00.125 00.117 | 62.875 03.457± | 01.875 00.328± |
| | | | 3 | 04.825 00.120± | 66.625 01.520± | 11.156 00.238± | 09.763 00.440± | 37.750 02.737± | 05.750 01.284± | 00.000 00.000 | 55.500 03.226± | 01.375 00.346± |
| | Non-challenged control | | 4 | 05.740 00.357± | 62.375 00.900± | 10.630 00.299± | 12.731 00.774± | 37.500 01.871± | 04.750 01.867± | 01.375 00.856 | 54.875 02.5 01± | 01.375 00.351± |
| | challenged by infected | blood | 5 | 04.640 00.424± | 48.750 02.320± | 07.844 00.359± | 11.563 01.114± | 38.750 02.920± | 02.625 00.466± | 00.375 00.351 | 55.125 02.786± | 03.125 00.372± |
| | | ticks | 6 | 05.843 00.274± | 65.875 01.482± | 09.219 00.200± | 12.688 00.702± | 33.750 02.530± | 03.375 00.529± | 00.875 00.482 | 61.000 02.574± | 01.000 00.354± |
| | Non-challenged control | | 7 | 05.158 00.200± | 78.375 01.286± | 12.500 00.214± | 11.494 00.551± | 32.000 01.358± | 02.875 00.375± | 00.000 00.000 | 62.500 01.194± | 01.000 00.306± |

Table (4)

Results of blood picture in donkeys vaccinated by American Babesia equi vaccine

| Blood picture / parameters of Animals | | | | Total erythrocytic Count | Haemoglobin content gm | Haemoglobin content % | Total leukocytic Count | Differential leukocytic count: Neutrophils % | Eosinophils % | Basophils % | Lymphocytes % | Monocytes % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3 weeks pre-vaccination | | | 8 | 05.977 00.485± | 65.000 00.943± | 10.420 00.180± | 10.350 01.616± | 33.330 10.640± | 02.330 00.980± | 01.670 00.720 | 61.330 01.960± | 01.000 00.820± |
| | | | 9 | 05.497 00.248± | 65.970 01.440± | 10.500 00.240± | 15.717 01.731± | 39.000 07.850± | 02.670 00.720± | 00.330 00.070 | 53.000 04.640± | 01.670 00.270± |
| | | | 10 | 05.753 00.214± | 60.000 01.886± | 09.670 00.300± | 15.383 01.516± | 39.000 02.160± | 02.330 00.720± | 02.000 00.470 | 55.000 01.700± | 01.330 00.270± |
| | | | 11 | 04.360 00.171± | 55.000 | 09.000 | 12.067 00.566± | 35.670 03.070± | 01.330 00.270± | 04.670 00.270± | 56.670 02.600± | 01.670 00.270± |
| | | | 12 | 04.640 00.209± | 64.000 01.700± | 10.330 00.250± | 17.950 01.059± | 39.670 03.600± | 00.330 00.270± | 03.670 00.720 | 53.670 03.660± | 01.330 00.270± |
| | | | 13 | 06.350 00.307± | 69.670 00.544± | 11.170 00.140± | 19.217 02.784± | 41.330 06.330± | 01.330 00.270± | 01.000 00.470 | 56.000 06.480± | 01.330 00.270± |
| | | | 14 | 04.983 00.321± | 68.667 00.544± | 10.917 00.136± | 14.933 01.184± | 33.667 05.504± | 04.667 02.288± | 00.000 00.000 | 56.330 08.450± | 02.000 00.817± |
| 10 weeks post-vaccination | vaccinated donkeys | | 8 | 05.459 00.190± | 57.100 00.842± | 09.225 00.139± | 10.540 00.209± | 34.100 01.769± | 02.500 00.292± | 01.200 00.506 | 60.800 01.561± | 01.400 00.323± |
| | | | 9 | 06.189 00.298± | 66.600 01.340± | 10.375 00.504± | 13.145 00.713± | 37.400 01.935± | 02.400 00.696± | 01.400 00.429 | 56.900 02.071± | 00.900 00.411± |
| | | | 10 | 05.162 00.159± | 56.800 00.360± | 09.200 00.069± | 14.110 01.348± | 43.400 02.475± | 02.900 00.877± | 00.900 00.411 | 50.900 02.381± | 02.000 00.520± |
| | | | 11 | 05.276 00.174± | 57.500 00.828± | 09.325 00.142± | 11.530 00.442± | 27.700 03.087± | 06.600 01.401± | 02.600 00.897 | 51.900 08.155± | 01.600 01.200± |
| | Non-vaccinated donkeys | | 12 | 05.746 00.197± | 57.300 01.386± | 09.275 00.208± | 13.190 00.854± | 30.500 02.160± | 03.300 00.722± | 00.800 00.341 | 64.900 02.674± | 00.500 00.158± |
| | | | 13 | 06.158 00.273± | 63.200 02.230± | 10.200 00.0346 | 13.555 00.771± | 37.800 02.630± | 03.500 01.177± | 01.500 00.765 | 56.600 02.847± | 00.800 00.276± |
| | | | 14 | 05.489 00.141± | 77.100 02.758± | 12.375 00.181± | 17.400 00.490± | 35.000 01.490± | 03.800 00.660± | 00.500 00.381 | 60.700 02.404± | 01.900 00.411± |
| 8 weeks post-challenge | challenged by infected ticks | blood | 8 | 04.191 00.208± | 47.375 00.450± | 06.231 00.122± | 10.100 00.530± | 34.000 01.912± | 01.500 00.345± | 00.125 00.117 | 62.500 00.031± | 01.625 00.706± |
| | | | 9 | 05.368 00.208± | 62.250 03.381± | 09.563 00.537± | 12.825 00.959± | 35.625 01.503± | 03.000 00.848± | 01.125 00.598 | 58.125 01.736± | 02.125 00.351± |
| | | | 10 | 05.306 00.266± | 59.500 01.392± | 09.563 00.621± | 17.763 01.624± | 42.250 04.643± | 01.125 00.449± | 00.625 00.466 | 52.375 04.500± | 02.375 00.351± |
| | Non-challenged control | | 11 | 05.740 00.357± | 62.375 00.900± | 10.630 00.299± | 12.731 00.774± | 37.500 01.871± | 04.750 01.867± | 01.375 00.856 | 54.875 02.540± | 01.375 00.351± |
| | challenged by infected ticks | blood | 12 | 04.640 00.424± | 48.750 02.320± | 07.844 00.359± | 11.563 01.114± | 38.750 02.920± | 02.625 00.466± | 00.375 00.351 | 55.125 02.786± | 03.125 00.372± |
| | | | 13 | 05.843 00.274± | 65.875 01.482± | 09.219 00.200± | 12.688 00.702± | 33.750 02.530± | 03.375 00.529± | 00.875 00.482 | 61.000 02.574± | 01.000 00.354± |
| | Non-challenged control | | 14 | 05.158 00.200± | 78.375 01.286± | 12.500 00.214± | 11.494 00.551± | 32.000 01.358± | 02.875 00.375± | 00.000 00.000 | 62.500 01.104± | 01.000 00.306± |

Table (5)

Results of coaplement fixation (CFT) and passive haemagglutination (PHA) tests in donkeys vaccinated by the local oil adjuvant Babesia equi vaccine

| parameters of animal / weeks | | vaccinated donkeys | | | | | | | | Non-vaccated control donkeys | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | challenged by infected | | | | | | Non challenged | | challenged by infected | | | | Non challenged | |
| | | blood | | ticks | | | | | | blood | | ticks | | | |
| | | 4 | | 5 | | 6 | | 7 | | 8 | | 9 | | 10 | |
| | | CFT | PHA | CFT | PHA | CFT | PHA | CFT | PHA | CFT | PHA | CFT | PHA | CFT | PHA |
| pre-vaccination | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | 2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | 3 | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| post-vaccination | 1 | 1:80 | - | 1:20 | - | 1:40 | - | 1:20 | 1:16 | - | - | - | - | - | - |
| | 2 | 1:80 | 1:2 | 1:40 | 1:8 | 1:40 | 1:2 | 1:20 | 1:32 | - | - | - | - | - | - |
| | 3 | 1:80 | 1:2 | 1:160 | 1:8 | 1:160 | 1:2 | 1:20 | 1:32 | - | - | - | - | - | - |
| | 4 | 1:80 | 1:2 | 1:320 | 1:16 | 1:160 | 1:2 | 1:20 | 1:32 | - | - | - | - | - | - |
| | 5 | 1:80 | 1:8 | 1:160 | 1:16 | 1:320 | 1:2 | 1:20 | 1:32 | - | - | - | - | - | - |
| | 6 | 1:80 | 1:8 | 1:320 | 1:16 | 1:320 | 1:8 | 1:40 | 1:64 | - | - | - | - | - | - |
| | 7 | 1:80 | 1:8 | 1:320 | 1:16 | 1:320 | 1:32 | 1:40 | 1:64 | - | - | - | - | - | - |
| | 8 | 1:80 | 1:8 | 1:160 | 1:32 | 1:160 | 1:32 | 1:40 | 1:64 | - | - | - | - | - | - |
| | 9 | 1:160 | 1:16 | 1:160 | 1:32 | 1:160 | 1:64 | 1:40 | 1:64 | - | - | - | - | - | - |
| | 10 | 1:160 | 1:32 | 1:160 | 1:64 | 1:160 | 1:64 | 1:40 | 1:32 | - | - | - | - | - | - |
| post-challenge | 1 | 1:80 | 1:16 | 1:8 | 1:32 | 1:80 | 1:32 | 1:40 | 1:32 | 1:20 | 1:16 | 1:20 | - | - | - |
| | 2 | 1:40 | 1:16 | 1:4 | 1:32 | 1:40 | 1:32 | 1:40 | 1:32 | 1:20 | 1:32 | 1:20 | - | - | - |
| | 3 | 1:40 | 1:16 | 1:2 | 1:32 | 1:40 | 1:32 | 1:20 | 1:32 | 1:20 | 1:32 | 1:40 | 1:8 | - | - |
| | 4 | 1:20 | 1:16 | 1:2 | 1:32 | 1:40 | 1:32 | 1:20 | 1:32 | 1:20 | 1:32 | 1:40 | 1:32 | - | - |
| | 5 | - | 1:16 | - | 1:32 | 1:20 | 1:32 | 1:10 | 1:16 | 1:40 | 1:32 | 1:40 | 1:32 | - | - |
| | 6 | - | 1:16 | - | 1:32 | - | 1:32 | 1:10 | 1:8 | 1:40 | 1:32 | 1:40 | 1:32 | - | - |
| | 7 | - | 1:16 | - | 1:32 | - | 1:16 | 1:10 | 1:8 | 1:40 | 1:32 | 1:40 | 1:32 | - | - |
| | 8 | - | 1:16 | - | 1:32 | - | 1:16 | 1:10 | 1:8 | 1:40 | 1:32 | 1:40 | 1:32 | - | - |

Table (6)

Results of complement fixation (CFT) and passive haemagglutination (PHA) tests in donkeys vaccinated by killed American Babesia equi vaccine

| parameters of animal / weeks | | vaccinated donkeys | | | | | | | | Non-vaccated control donkeys | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | challenged by infected | | | | | | Non challenged | | challenged by infected | | | | Non challenged | |
| | | blood | | ticks | | | | | | blood | | ticks | | | |
| | | 8 | | 9 | | 10 | | 11 | | 12 | | 13 | | 14 | |
| | | CFT | PHA | CFT | PHA | CFT | PHA | CFT | PHA | CFT | PHA | CFT | PHA | CFT | PHA |
| pre-vaccination | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | 2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | 3 | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| post-vaccination | 1 | - | 1:16 | 1:10 | - | 1:10 | - | 1:20 | 1:16 | - | - | - | - | - | - |
| | 2 | 1:10 | 1:32 | 1:10 | 1:64 | 1:10 | 1:64 | 1:20 | 1:32 | - | - | - | - | - | - |
| | 3 | 1:20 | 1:32 | 1:10 | 1:64 | 1:10 | 1:64 | 1:20 | 1:32 | - | - | - | - | - | - |
| | 4 | 1:20 | 1:32 | 1:10 | 1:64 | 1:10 | 1:64 | 1 20 | 1:32 | - | - | - | - | - | - |
| | 5 | 1:20 | 1:32 | 1:10 | 1:64 | 1:10 | 1:64 | 1:40 | 1:32 | - | - | - | - | - | - |
| | 6 | 1:20 | 1:32 | 1:10 | 1:64 | 1:10 | 1:64 | 1:40 | 1:64 | - | - | - | - | - | - |
| | 7 | 1:20 | 1:64 | 1:10 | 1:64 | 1:10 | 1:64 | 1:40 | 1:64 | - | - | - | - | - | - |
| | 8 | 1:40 | 1:128 | 1:20 | 1:64 | 1:20 | 1:64 | 1:40 | 1:64 | - | - | - | - | - | - |
| | 9 | 1:40 | 1:128 | 1:40 | 1:64 | 1:20 | 1:128 | 1:40 | 1:64 | - | - | - | - | - | - |
| | 10 | 1:40 | 1:64 | 1:80 | 1:128 | 1:20 | 1:128 | 1:40 | 1:32 | - | - | - | - | - | - |
| post-challenge | 1 | 1:20 | 1:32 | 1:40 | 1:64 | 1:10 | 1:64 | 1:40 | 1:32 | 1:20 | 1:16 | 1:20 | - | - | - |
| | 2 | 1:20 | 1:32 | 1:20 | 1:64 | 1:10 | 1:64 | 1:40 | 1:32 | 1:20 | 1:32 | 1:20 | - | - | - |
| | 3 | 1:20 | 1:32 | 1:20 | 1:64 | 1:10 | 1:64 | 1:40 | 1:32 | 1:20 | 1:32 | 1:40 | 1:8 | - | - |
| | 4 | 1:20 | 1:32 | 1:20 | 1:64 | 1:10 | 1:64 | 1:20 | 1:32 | 1:20 | 1:32 | 1:40 | 1:32 | - | - |
| | 5 | 1:20 | 1:16 | 1:20 | 1:64 | 1:10 | 1:64 | 1:20 | 1:16 | 1:40 | 1:32 | 1:40 | 1:32 | - | - |
| | 6 | 1:20 | 1:16 | 1:20 | 1:64 | 1:10 | 1:64 | 1:10 | 1:8 | 1:40 | 1:32 | 1:40 | 1:32 | - | - |
| | 7 | 1:10 | 1:16 | 1:20 | 1:64 | 1:10 | 1:32 | 1:10 | 1:8 | 1:40 | 1:32 | 1:40 | 1:32 | - | - |
| | 8 | 1:10 | 1:16 | 1:10 | 1:32 | 1:10 | 1:16 | 1:10 | 1:8 | 1:40 | 1:32 | 1:40 | 1:32 | - | - |