Veterinary Research Communications, 8 (1984) 255—267
Elsevier Science Publishers B.V., Amsterdam — Printed in The Netherlands

APPLICATIONS OF ENZYME-LINKED IMMUNOSORBENT ASSAY IN VETERINARY MEDICINE: A BIBLIOGRAPHY

S. CHARAN* and O.P. GAUTAM

Departments of Microbiology and Medicine, College of Veterinary Sciences, Haryana Agricultural University, Hissar-125004 (India)

*Present address: Institut für Pathologie, Abt. für Exp. Pathologie, Universitätsspital, Zürich, 8091 Zürich (Switzerland)

(Accepted 7 May 1984)

ABSTRACT

Charan, S. and Gautam, O.P. 1984. Application of enzyme-linked immunosorbent assay in veterinary medicine: a bibliography. Vet. Res. Commun., 8: 255-267.

During the last decade enzyme-linked immunosorbent assay has been a technique of major interest to those engaged in immunodiagnostics of human and animal diseases. Owing to its simplicity, specificity and sensitivity it has taken precedence over other conventional assays, including radioimmunoassay on the grounds of freedom from radiation hazards. Many applications of this assay have been developed in veterinary medicine and they are listed in this article.

INTRODUCTION

The ideal characteristics of a diagnostic test are speed, sensitivity, specificity, safety, potential for automation, broad applicability and potential for field use. The search for an assay to meet these criteria led to the development of enzyme-linked immunosorbent assay (ELISA) which also has the following advantages:

1. Enzyme-labelled antigens and antibodies stored under sterile conditions can be used for years without any appreciable loss of their enzymatic and immunological activities (Sharma et al., 1982).
2. Enzyme-immunoassays are easy to manipulate and they pose a minimum risk of contamination, pollution and health hazards.
3. There is no need for costly equipment and the assay can be performed easily in a conventionally equipped laboratory.
4. The possibility of using fluorogenic substrates makes enzyme immunoassays a tool of tremendous potential, since they can detect extremely small quantities of antigen or antibody, e.g.

0165-7380/84/$03.00

to the extent of 10^{-17}g of cholera toxin.
The serious limitation of such an assay is that it requires a meticulous standardization for each system independently. The optimal timings for each step and for the other requirements such as concentration, incubation temperature and pH have to be ascertained precisely, maintaining sufficient control for each reagent. Fortunately, monoclonal antibody has been very useful for generating antisera of predictable specificity, able to overcome background reaction.

The enzyme immunoassays were pioneered a decade ago by Engvall and Perlmann (1971) and are now methods of choice in routine diagnosis. In veterinary practice, sero-epidemiological surveillance is often more important than the diagnosis of disease in an individual animal. ELISA can be applied to gain information regarding the spread of infections, the effectiveness of vaccines in stimulating antibody production and the levels of herd immunity. Many reviews dealing with the various aspects of the assay have been published (Schuurs and Van Weemen, 1977; Jacobson et al., 1978; Voller et al., 1978; O'Beirne and Cooper, 1979). The present review summarizes the applications of the technique specifically in veterinary medicine.

APPLICATION OF ELISA

In principle, ELISA can be applied to all antigen-antibody systems. Numerous applications of ELISA have been developed to-date, including infectious diseases (viral, bacterial, parasitic, fungal), hormones, oncofetal proteins, toxins, serum proteins, drugs and others such as snake venom, adenosine and DNA.

Possibly the greatest potential for ELISA rests in its ability to detect the antigens of infectious agents in clinical specimens. The use of staphylococcal protein-A as the substitute for specific immunoglobulin has doubtlessly increased the horizon of the technique by increasing its versatility and rendering it more economical (Potgieter et al., 1980). However, in certain instances it may be at the cost of the specificity. A wide range of applications has been discovered with regard to detecting a single antigen or antibody, and the scope of the technique may be further broadened in future by screening more than one type of antigen or antibody simultaneously in a single sample by carefully sensitizing the solid phase.

TABLE 1

Publications dealing with the applications of ELISA in veterinary medicine

VIRUS	
African swine fever	Saunders et al., 1977
	Wardley et al., 1979
	Hamdy et al., 1981
Aleutian disease	Wright et al., 1980
Avian adenovirus	Dawson et al., 1980
Avian encephalomyelitis	Sytuo and Matsumoto, 1981
Avian infectious bronchitis	Garcia and Bankowski, 1980
	Mockett and Darbyshire, 1981
	Soula and Moreau, 1981
	Nandapalan et al., 1982
Avian leukosis	Smith et al., 1979
Aujeszky's disease	Snyder and Stewart, 1977
	Moutou et al., 1978
	Briaire, 1979
	Todd et al., 1981
Blue tongue	Hubschle et al., 1981
Bovine leukosis	Ressang et al., 1978
	Behrens, 1979
	Todd et al., 1980
	Gielkens et al., 1981
Bovine parvovirus	Alberty et al., 1981
Canine adenovirus	Noon et al., 1979
Canine distemper	Noon et al., 1980
	Bernard et al., 1982
Coronavirus	Ellen et al., 1979
	Callebaut et al., 1982
Equine infectious anaemia	Shen et al., 1979
	Suzuki et al., 1982.
Equine infectious peritonitis	Osterhaus et al., 1979
Feline leukemia	Sabin and Finnimore, 1980
	Waits et al., 1982
Foot and mouth disease	Abu-Elzein and Crowther, 1978
	Abu-Elzein and Crowther, 1979
	Crowther and Abu-Elzein, 1979

Infectious bovine rhinotracheitis	Bommeli et al., 1980
	Herring et al., 1980
	Solsona et al., 1980
	Bolton et al., 1981
Infectious bursal disease	Marquardt et al., 1980
	Howie and Thorsen, 1981
Marek's disease	Srivastava et al., 1982
Murine leukemia	Nexo, 1976
Newcastle disease	Charan et al., 1981
	Charan et al., 1983
Porcine cytomegalovirus	Assaf et al., 1982
Rabies	Atanasiu et al., 1977
Reovirus	Slaght et al., 1978
Rinderpest	Rossiter et al., 1981
	Anderson et al., 1982
Rotavirus	Scherrer and Bernard, 1977
	Ellen and Leeuw, 1978
	Yolken et al., 1978
	Bachmann, 1979
	Payment et al., 1979
	Stucker et al., 1979
	Grauballe et al., 1981
Sendai	Parker et al., 1979
Swine vesicular disease	Hamblin and Crowther, 1982
Togavirus	Roehrig, 1982
Visna/maedi	Houwers and Gielken, 1979

BACTERIA

Brucellosis	Byrd et al., 1979
	Magee, 1979
	Ruppanner et al., 1980
	Thoen et al., 1980 b
Chlamydia	Rai et al., 1982
	Fuentes et al., 1982
Corynebacterium	Fekadu et al., 1979
Contagious equine metritis	Sahu et al., 1979
E.coli	Ellen et al., 1979 b
Dermatophilus	Lloyd, 1981
Haemophilus	Nicolet et al., 1981

Johne's disease	Jorgensen and Jensen, 1978
Mycoplasma	Gee, 1979
	Onoviran and Taylor-Robinson,1979
	Ansari et al., 1980
	Boothby et al., 1981, 1982
	Lutz et al., 1982
Pasteurella	Burrells et al., 1979
	Marshall et al., 1981
Pseudomonas	Ueda et al., 1982
Streptococcus	Logan et al., 1982
Tuberculosis	Morris et al., 1979
	Reggiardo et al., 1980
	Thoen et al., 1980c

PARASITES

Anaplasma	Thoen et al., 1980 a
Babesia	Bidwell et al., 1978
	Young and Purnell, 1980
Dictyocaulus	Marius et al., 1979
Dirofilaria	Grieve et al., 1981
Fasciola	Burden and Hammet, 1978
	Hillyer and Weil, 1979
	Farrell et al., 1981
Ostertagia	Keus et al., 1981
Sarcocystis	Tadros et al., 1979
Strongyles	Murrell et al., 1982
Taenia	Craig, 1979
	Harrison and Sewell, 1981
Toxocara	Savigny et al., 1979
Toxoplasma	Ambroise-Thomas et al., 1978
	Denmark and Chessum, 1978
	Lin et al., 1980
	Yen et al., 1981
Trichinella	Ruitenberg et al., 1976
	Taylor and Kenny, 1978
	Taylor et al., 1978
	Ruitenberg and Buys, 1979
	Knapen et al., 1980
Trypanosoma	Luckin and Mehlitz, 1978
	Luckin et al., 1978
	Silayo et al., 1980

MISCELLANEOUS

Enterotoxins	Fey et al., 1980
Fungi	Ambroise-Thomas et al., 1978
	Richardson et al., 1979
Hormones	Larsson and Lumsden, 1980
	Arnstadt and Cleere, 1981
Immunoglobulins	Butler et al., 1980
Meat identification	Kangethe et al., 1982

REFERENCES

Abu-Elzein, E.M.E. and Crowther, J.R., 1978. Enzyme labelled immunosorbent assay techniques in foot and mouth disease virus research. J. Hyg. (London), 80: 391-399.

Abu-Elzein, E.M.E. and Crowther, J.R., 1979. The specific detection of foot and mouth disease virus whole particle antigen (140 S) by enzyme labelled immunosorbent assay. J. Hyg. (London), 83: 127-134.

Alberty, C.F., Bodine, A.B. and Barnes, M.A., 1981. The enzyme-linked immunosorbent assay (ELISA) for detection of antibodies to the bovine parvovirus. J. Dairy Sci., 64: (Supp) 187-188.

Ambroise-Thomas, P., Desgeorges, P.T. and Monget, D., 1978. Diagnosis of parasitic diseases by enzyme-linked immunosorbent assay (ELISA) with a modified micro-method: results for toxoplasmosis, amoebiasis, trichinosis, hydatidosis and aspergillosis. Bull. Wld. Hlth. Org., 56: 797-804.

Anderson, J., Rowe, L.W., Taylor, W.P. and Crowther, J.R., 1982. An enzyme-linked immunosorbent assay for detection of IgG, IgA&IgM antibodies to rinderpest-virus in experimentally infected cattle. Res. Vet. Sci., 32: 242-247.

Ansari, A., Taylor, R.F. and Chang, T.S., 1980. Development of mycoplasma enzyme linked immunosorbent assay (Myco-ELISA) for the detection of antibody for mycoplasma infections in chickens. Absts. Annual meeting of Amer. Soc. Microbiologists, 80: 77.

Arnstadt, K.I. and Cleere, W.F., 1981. Enzyme immunoassay for determination of progesterone in milk from cow. J. Reprod. Fert., 62: 173-180.

Assaf, R., Bouillant, A.M. and Francko, E.D., 1982. Enzyme linked immunosorbent assay (ELISA) for the detection of antibodies to porcine cytomegalovirus. Canad. J. Comp. Med., 46: 183-185.

Atanasiu, P., Savy, V. and Perrin, P., 1977. Rapid detection of rabies antibodies by immunoenzymatic assay. Ann. Microbiol. (Inst. Pasteur), 128 A: 489-498.

Bachmann, P.A., 1979. Demonstration of rotavirus in faeces. Experiences with the enzyme linked immunosorbent assay (ELISA). Zbl. Vet. Med., 26B: 835-842.

Behrens, F., 1979. Diagnosis of bovine leukosis: ELISA, a new technique. Berl. Muench. Tierarztl. Wochenschr., 97: 429-432.

Bernard, S.L., Shen, D.T. and Gorham, J.R., 1982. Antigen requirement and specificity of enzyme-linked immunosorbent assay for detection of canine IgG against canine distemper viral antigen. Amer. J. Vet. Res., 43: 2266-2269.

Bidwell, D.E., Turp, P., Joyner, L.P., Payne, R.C. and Purnell, R.E., 1978. Comparison of serological tests for babesia in British cattle. Vet. Rec., 103: 446-449.

Bolton, D.C., Chu, H.J., Ardans, A.A., Kelly, B. and Zee, Y.C., 1981. Evaluation of critical parameters of a sensitive ELISA test using purified infectious bovine rhino-tracheitis. Vet. Microbiol., 6: 265-279.

Bommeli, W.R., Kihm, U., Lazarowicz, M. and Steck., F., 1980. Rapid detection of antibodies of infectious bovine rhinotracheitis (IBR) virus by micro-enzmye linked immunosorbent assay (Micro-ELISA). Proc. 2nd Int. Symp. Vet. Lab. Diagn. Lucerne, Switzerland, pp. 236-239.

Boothby, J.T., Jasper, D.E., Lutz, H. and Rollins, M.H., 1982. Gel electrophoresis derived enzyme linked immunosorbent assay for serum from cows resistant to and cows susceptible to challenge exposure with Mycoplasma bovis. Amer. J. Vet. Res., 43: 553-556.

Boothby, J.T., Jasper, D.E., Rollins, M.H. and Thomas, C.B., 1981. Detection of Mycoplasma bovis specific IgG in bovine serum by enzyme-linked immunosorbent assay. Amer. J. Vet. Res., 42: 1242-1247.

Briaire, J., 1979. An enzyme linked immunosorbent assay (ELISA) for the detection of antibodies against Aujeszky's disease virus in pigs sera. Zbl. Vet. Med., 26B: 76-81.

Burden, D.J. and Hammet, N.C., 1978. Microplate enzyme linked immunosorbent assay for antibody to Fasciola hepatica in cattle. Vet. Rec., 103: 153.

Burrells, C., Wells, P.W. and Dawson, S. Mcl., 1979. The quantitative estimation of antibody to Pasteurella haemolytica in sheep sera using a micro-enzmye linked immunosorbent assay (ELISA). Vet. Microbiol., 3: 291-301.

Butler, J.E., McGivern, P.L., Cantarero, L.A. and Peterson, L., 1980. Application of the amplified enzyme-linked immunosorbent assay: Comparative quantitation of bovine serum IgG_1, IgG_2, IgA and IgM antibodies. Amer. J. Vet. Res., 41: 1479-1491.

Byrd, J.W., Heck, F.C. and Hidalgo, R.J., 1979. Evaluation of the enzyme-linked immunosorbent assay for detecting Brucella abortus antibodies. Amer. J.Vet. Res., 40: 896-898.

Callebaut, P., Debouck, P. and Penserat, M., 1982. Enzyme linked immunosorbent assay for the detection of corona-like agents and its antibody in pigs with porcine epidemic diarrhoea. Vet. Microbiol., 7: 295-306.

Charan, S., Mahajan, V.M. and Rai, A., 1983. Comparison of sero-reactivity of lentogenic, mesogenic and velogenic strains of Newcastle disease virus by enzyme-linked immunosorbent assay and haemagglutination inhibition tests on human sera. Zbl. Vet. Med., 30B: 55-60.

Charan, S., Rai, A. and Mahajan, V.M., 1981. Comparison of enzyme linked immunosorbent assay and haemagglutination inhibition test for the detection of Newcastle disease virus antibodies in human sera. J. Clin. Path., 34: 90-92.

Craig, P.S., 1979. Serological diagnosis of Taenia saginata in cattle using micro-ELISA. Victorian Vet. Proc., 37:39.

Crowther, J.R. and Abu-Elzein, E.M.E., 1979. Detection and quantitation of foot and mouth disease virus by enzyme-labelled immunosorbent assay technique. J. Gen. Virol., 42: 597-602.

Dawson, G.J., Orsi, L.M., Yates, V.J., Chang, P.W. and Pronovost, A.D., 1980. An enzyme linked immunosorbent assay for detection of antibodies of avian adenovirus and avian adenovirus associated virus in chicken. Avian Dis., 24: 393-402.

Denmark, J.R. and Chessum. B.S., 1978. Standardization of enzyme linked immunosorbent assay (ELISA) and the detection of Toxo-

plasma antibody. Med. Lab. Sci., 35: 227-232.
Ellen, D.J. and Leeuw, P.W., 1978. Enzyme linked immunosorbent assay for diagnosis of rotavirus in calves. J.Clin. Microbiol., 6: 530-532.
Ellen, D.J., Balken, J.A.M., Van and Locum, P.W. De., 1979a. Diagnosis of bovine corona virus infection with haemadsorption-elution haemagglutination assay (HEHA) and enzmye-linked immunosorbent assay (ELISA). Proc. 2nd Int. Symp. on Neonatal Diarrhoea. Oct. 3-5, 1978. Ed.S.D. Aeres, Univ. of Saskatchewan, Canada, Vet. Infect. Dis. Organisation, pp.321-329.
Ellen, D.J., Leeuw, P.W. and Rozemond, H., 1979b. Detection of the K 99 antigen of E.coli in calf faeces by enzyme-linked immunosorbent assay (ELISA). Vet. Quart., 1: 169-175.
Engvall, E. and Perlmann, P., 1971. Enzyme-linked immunosorbent assay of IgG. Immunochemistry, 8: 871-874.
Farrell, C.J., Shen, D.T., Westcott, R.B. and Lang, B.Z., 1981. An enzyme-linked immunosorbent assay for diagnosis of Fasciola hepatica infection in cattle. Amer. J. Vet. Res., 42: 237-240.
Fekadu, M., Ramtzien, M.H. and Prage, L., 1979. Quantitation of antibodies to Corynebacterium pyogenes in sera from cows. Methods and applications, Vet. Microbiol., 4: 235-245.
Fey, H., Stiffler, R.G. and Burkhard, G., 1980. Experiences with the detection and measurement of staphylococcal enterotoxins by ELISA. Proc. 2nd. Int. Symp. Vet. Lab. Diagn. Lucerne, Switzerland, pp. 250-256.
Fuentes, V., Bissac, H., Corbel, C., Haider, F., Lefebvre, J.F. and Orfila, J., 1982. Application of enzyme-linked immunosorbent assay to chlamydial antibodies. J. Biol. Stand., 10: 303-309.
Garcia, Z. and Bankowski, R.A., 1980. A comparison of a tissue culture virus neutralization test and the enzyme-linked immunosorbent assay for measurement of antibodies to infectious bronchitis. Avian Dis., 25: 121-130.
Gee, R.W., 1979. ELISA for detection of antibody against mycoplasms. Vet. Rec., 105: 360.
Gielkens, A.L.J., Ressang, A.A., Ijzermann, J. and Quak, T., 1981. Test protocol of an enzyme-linked immunosorbent assay (ELISA) for the detection of antibodies against bovine leukosis virus. Vet. Quart., 3: 34-37.
Grauballe, P.C., Vestergaards, B.F., Meyling, A. and Genner, J., 1981. Optimized enzyme-linked immunosorbent assay for detection of human and bovine rotavirus in stools: Comparison with electron microscopy, immunoelectro-osmophoresis and fluorescent antibody technique. J. Med. Virol., 7: 29-40.
Grieve, R.B., Mika-Johnson, M., Jacobson, R.H. and Cypess, R.H., 1981. Enzyme-linked immunosorbent assay for measurement of antibody response to Dirofilaria immitis in experimentally infected dogs. Amer. J. Vet. Res., 42: 66-69.
Hamblin, C. and Crowther, J.R., 1982. A rapid enzyme-linked immunosorbent assay for the serological confirmation of swine vesicular disease. Brit. Vet. J., 138: 247-252,
Hamdy, F.M., Colgrove, G.S., Rodriguez, E.M., Snyder, M.L. and Stewart, W.C., 1981. Enzyme linked immunosorbent assay for the diagnosis of African swine fever. Amer. J. Vet. Res., 42: 1441-1444.
Harrison, L.J. S. and Sewell, M.M.H., 1981. A comparison of the enzyme linked immunosorbent assay and the indirect haemagglutination technique applied to sera from cattle experimentally infected with Taenia saginata. Vet. Immmunol. Immunopathol., 2: 67-73.
Herring, A.J., Nettleton, P.F. and Burrells, C.,1980. A microenzyme-linked immunosorbent assay for the detection of antibodies to infectious bovine rhinotracheitis virus. Vet. Rec., 107: 155-156.

Hillyer, G.V. and Weil, N.S. D., 1979. Use of immunologic techniques to detect chemotherapeutic success in infections with Fasciola hepatica. II. The enzyme linked immunosorbent assay in infected rats and rabbits. J. Parasitol., 65: 680-684.

Houwers, D.J. and Gielkens, A.L. J., 1979. An ELISA for the detection of maedi/visna antibody (Letter). Vet. Rec., 104: 611.

Howie, R. and Thorsen, J., 1981. An enzyme-linked immunosorbent assay (ELISA) for infectious bursal disease. Canad. J. Comp. Med., 45: 51-55.

Hubschle, O.J. B., Lorenz, R.J. and Matheka, H.D., 1981. Enzyme-linked immunosorbent assay for detection of the blue tongue virus antibodies. Amer. J. Vet. Res., 42: 61-65.

Jacobson, R.M., Grieve, R.B. and Cypess, R.H., 1978. The ELISA assay in diagnosis of parasitic infections. Proc. Amer. Assoc. Vet. Lab. Diagnos., 21: 367-375.

Jorgensen, J.B. and Jensen, P.T., 1978. Enzyme-linked immunosorbent assay (ELISA) for detection of antibodies to Mycobacterium paratuberculosis in cattle. Acta Vet. Scand., 19: 310-312.

Kangethe, F.L., Jones, S.J. and Patterson, R.L.S., 1982. Identification of the species origin of fresh meat using an enzyme-linked immunosorbent assay procedure. Meat Sci., 7: 229-240.

Keus, A., Kloosterman, A. and Brink, R. Van Den., 1981. Detection of antibodies to Cooperia spp. and Ostertagia spp. in calves with enzyme linked immunosorbent assay. Vet. Parasitol., 8: 229-236.

Knappen, R. Van, Franchimont, J.H., Ruitenberg, E.J., André, P., Baldelli, B., Gibson, T.E., Gottal, C., Henriksen, S.A., Kohler, G., Ronéus, O., Skovgaard, N., Soulé, C., Strickland, K.L., Taylor, S.M., 1980. Comparison of the enzyme linked immunosorbent assay (ELISA) with three other methods for the detection of Trichinella spiralis infection in pigs. Vet. Parasitol., 7: 229-240.

Larsson, M. and Lumsden, J.H., 1980. Evaluation of an enzyme-linked immunosorbent assay (ELISA) for determination of plasma thyroxine in dogs. Zbl. Vet. Med., 27A: 352-358.

Lin, T.M., Halbert, S.P. and O'Conner, G.R., 1980. Standardized quantitative enzyme linked immunoassay for antibodies to Toxoplasma gondii. J. Clin. Microbiol., 11: 675-681.

Lloyd, D.H., 1981. Measurement of antibody to Dermatophilus congolensis in sera from cattle in the west of Scotland by enzyme-linked immunosorbent assay. Vet. Rec., 109: 426-427.

Logan, E.F., Meneeley, D.J. and Maekie, D.P., 1982. Enzyme-linked immunosorbent assay for Streptococcus agalactiae antibodies in bovine milk. Vet. Rec., 110: 247-249.

Luckin, A.G., Grag, A.R. and Rae, P., 1978. Comparison of the diagnostic value of serum immunoglobulin levels; an enzyme-linked immunosorbent assay and a fluorescent antibody test in experimental infection with Trypanosoma evansi in rabbits. Ann. Trop. Med. Parasitol., 72: 429-441.

Luckin, A. G. and Mehlitz, D., 1978. Evaluation of indirect fluorescent antibody test, enzyme-linked immunosorbent assay and quantification of immunoglobulins in the diagnosis of bovine trypanosomiasis. Trop. Anim. Health. Prod., 10: 149-159.

Lutz, H., Bruggmann, S., Corboz, L., Muller, R., Limacher, W., Weber, H., Wissler, K. and Theilen, G.H., 1981. Combination of polyacrylamide gel electrophoresis with enzyme-linked immunosorbent assay: a simple method determining antibody specificity and detection of antigens in complex mixture. Vet. Immunol. Immunopathol., 2: 425-440.

Magee, J.T., 1979. An enzyme-linked immunosorbent assay for Brucella abortus antibodies. J. Med. Microbiol., 13: 167-172.

Maiolini, R., Ferrua, B. and Masseyeff, R., 1975. Enzyme immunoassay of human alfa-fetoprotein. J. Immunol. Meth., 6: 355-362.
Marius, V., Bernard, S., Raynaud, J.P., Pery, P. and Luffau, G., 1979. Dictyocaulus viviparus in calves: quatitation of antibody activities in sera and respiratory secretions by immunoenzymatic analysis. Ann. Rech. Vet., 10: 55-63.
Marquardt, W.W., Johnson, R.B., Odenwald, W.F. and Schlotthobler, B.A., 1980. An indirect enzyme-linked immunosorbent assay (ELISA) for measuring antibodies in chicken infected with infectious bursal disease virus. Avian Dis., 24: 375-380.
Marshall, M.S., Rabison, R.A. and Jesnon, M.M., 1981. Use of an enzyme linked immunosorbent assay to measure antibody responses in turkeys against Pasteurella multocida. Avian Dis., 25: 964-971.
Mockett, A.P.A. and Darbyshire, J.H., 1981. Comparative studies with an enzyme-linked immunosorbent assay (ELISA) for antibodies to avian infectious bronchitis virus. Avian Path., 10: 1-10.
Morris, J.A., Stevens, A.E., Suart, P. and Little, T.W.A., 1979. A pilot study to assess the usefulness of ELISA in detecting tuberculosis in badgers. Vet. Rec., 104: 14.
Moutou, F., Toma, B. and Fortier, M., 1978. Application of enzyme-linked immunosorbent assay for diagnosis of Aujeszky's disease in swine. Vet. Rec., 103: 264.
Murrell, K.D., Graham, C.E. and Anderson, W.R., 1982. Evaluation of three immunodiagnostic procedures for porcine strongyloidiosis. Amer. J. Vet. Res., 43: 702-705.
Nandapalan, N., Wilcox, G.E. and Penhale, W.J., 1982. Enzyme-linked immunosorbent assay for the detection of antibodies to infectious bronchitis virus. Avian Dis., 26: 171-176.
Nexo, B.A., 1976. A plaque assay for murine leukemia virus using enzyme coupled antibodies. Virology, 77: 849-852.
Nicolet, J., Paroz, P., Krawinkler, M. and Baumgarther, A., 1981. An enzyme-linked immunosorbent assay using EDTA extracted antigen for the serology of Haemophilus pleuropneumonia. Amer. J. Vet. Res., 42: 2139-2142.
Noon, K.F., Rogul, M., Binn, L.N., Keefe, T., Marchwicki, R.H. and Appel, M.J., 1980. Enzyme linked immunosorbent assay for evaluation of antibodies to canine distemper virus. Amer. J. Vet. Res., 41: 605-609.
Noon, K.F., Rogul, M., Binn, L.N., Keefe, T.J., Marchwicki, R.H., Thomas, R. and Cicco, B.T.De., 1979. An enzyme linked immunosorbent assay for the detection of antibodies to canine adenoviruses. Lab. Anim. Sci., 29: 603-609.
O'Beirne, A.J. and Cooper, H.R., 1979. Heterogeneous enzyme immunoassay. J. Histochem. Cytochem., 27: 1148-1162.
Onoviran, O. and Taylor-Robinson, D., 1979. Detection of antibody against Mycoplasma mycoides subsp. mycoides in cattle by an enzyme-linked immunosorbent assay. Vet. Rec., 105: 165-167.
Osterhaus, A., Kroon, A. and Wirahadiredja, R., 1979. ELISA for the serology of FIP virus (feline infectious peritonitis). Vet. Quart., 1: 59-62.
Parker, J.C., O'Beirne, A.J. and Collins, M.J., 1979. Sensitivity of enzyme-linked immunosorbent assay, complement fixation and haemagglutination inhibition serological tests for detection of Sendai virus antibodies in laboratory mice. J. Clin. Microbiol., 9: 444-447.
Payment, P., Marsolais, G., Trudal, M., Fauvel, M. Lamontage, L., Assaf, R. and Marois, P., 1979. Use of electronmicroscopy and enzyme-linked immunosorbent assay for the detection of rotavirus in neonatal calf diarrhoea. Canad. J. Comp. Med., 43: 328-329.

Potgieter, L.N.D., Rouse, B.T. and Webbmartin, T.A., 1980. Enzyme-linked immunosorbent assay using staphylococcal protein A for detecting virus antibodies. Amer. J.Vet. Res., 41: 978-980.

Rai, A., Charan, S. and Mahajan, V.M., 1982. Enzyme-linked immunosorbent assay for the detection of chlamydial antibodies in poultry associated individuals. Indian J.Med. Res., 76: 393-397.

Reggiardo, Z., Vazquez, E. and Schnaper, L., 1980. ELISA for antibodies against mycobacterial glycolipids. J. Immunol. Meth., 34: 55-60.

Ressang, A., Gielken, A.L. J., Quak, S., Mastenbrgek, N., Tuppert, C. and Castro, A. De., 1978. Studies on bovine leukosis. VI. Enzyme linked immunosorbent assay for the detection of antibodies to bovine leukosis virus. Ann. Res. Vet., 9: 663-666.

Richardson, M.D., White, L.O. and Warren, R.C., 1979. Detection of circulation antigen of Aspergillus fumigatus in sera of mice and rabbits by enzyme linked immunosorbent assay. Mycopath., 67: 83-88.

Roehrig, J.T., 1982. Development of an enzyme-linked immunosorbent assay for the identification of arthropod-borne togavirus antibodies. J. Gen. Virol., 63: 237-240.

Rossiter, P.B., Jessett, D.M. and Holmes, P., 1981. Micro ELISA test for detecting antibodies to rinderpest virus antigens. Trop. Anim. Health Prod., 13: 113-116.

Ruitenberg, E.J. and Buys, J., 1979. Trichinella spiralis infection in pigs. Comparison of homologous passive cutaneous anaphylactic reactions with the enzyme-linked immunosorbent assay (ELISA). Vet. Parasitol., 5: 73-78.

Ruitenberg, E.J., Steerenberg, P.A., Brosi, B.J.M. and Buys, J., 1976. Repeatability of ELISA as a control method for detection of Trichinella spiralis infection in conventionally raised pigs. J. Immunol. Meth., 10: 67-83.

Ruppanner, R., Meyer, M. E., Willeberg, P. and Behymer, D., 1980. Comparison of ELISA with other tests using sera from heifers experimentally infected with Brucella abortus. Amer. J. Vet. Res., 41: 1329-1332.

Sabin, M. and Finnimore, P.M., 1980. A test for detection of feline leukemia virus. Aust. Vet. Prac., 10: 159-162.

Sahu, S.P., Hamdy, F.M. and Dardiri, A.H., 1978. Contagious equine metritis: development of enzyme linked immunosorbent assay to detect antibody to contagious equine metritis organism. Proc. U.S. Anim. Health Assoc., 83: 243-252.

Saunders, G.C., Clinard, E.H., Bartlett, M.L. and Sander, W.M., 1977. Application of the indirect enzyme labelled antibody microtest to the detection and surveillance of animal disease. J. Infect. Dis., 136S: 258-266.

Savigny, D.H. De., Voller, A. and Woodruff, A.W., 1979. Toxocariasis, serological diagnosis by enzyme immunoassay. J. Clin. Path., 32: 284-288.

Scherrer, R. and Bernard, S., 1977. Application of enzyme linked immunosorbent assay (ELISA) to the detection of calf rotavirus antibodies. Ann. Microbiol., 128A: 499-510.

Schuurs, A.H.W.M. and Van Weemen, B. K., 1977. Enyzme-immunoassay. Clin. Chim. Acta, 81: 1-40.

Sharma, A., Sriniwas, Usha Kiran, Bhargawa, D.K., Charan, S. and Chawla, T.C., 1982. Reproducibility and long term follow up of enzyme immunoassay. VII. International Conference on Defined Immunofluorescence, Immunoenzyme Studies and Related Techniques. Niagara Falls, New York, 1982. (Abstr. Immun.. Commun; 12:54).

Shen, D.T., Crawford, T.B. and Gorham, J.R., 1979. Enzyme-linked immunosorbent assay (ELISA) for detection of equine infectious anaemia viral antigen. J. Equine Med. Sur., 3: 303-307.

Silayo, R.S., Gray, A.P. and Luckins, A.G., 1980. Use of antigens of cultured Trypanosoma brucei in test for bovine trypanosomiasis. Trop. Anim. Health Prod., 12: 127-131.
Slaght, S., Yang, J., Vander, Heide, L. and Fredrickson, T., 1978. An enzyme immunosorbent assay (ELISA) for detecting chicken anti-reovirus antibody at high sensitivity. Avian Dis., 22: 802-805.
Smith, E.J., Fadly, A. and Okazaki, W., 1979. An enzyme-linked immunosorbent assay for detecting avian leukosis sarcoma virus. Avian Dis., 23: 698-707.
Snyder, M.L. and Stewart, W.C., 1977. Application of enzyme labelled test in pseudorabies. Proc. Amer. Assoc. Vet. Lab. Diagns., 20: 17-32.
Solsona, M., Perrin, B., Perrin, M. and Moussa, A., 1980. Detection of antibodies to bovine infectious rhinotracheitis virus by the ELISA technique. Bull. Acad. Vet. France, 53: 215-225.
Soula, A. and Moreau, Y., 1981. Antigen requirements and specificity of a microplate enzyme-linked immunosorbent assay (ELISA) for detecting infectious bronchitis viral antibodies in chicken serum. Arch. Virol., 67: 283-295.
Srivastava, R.N., Kaushik, A.K. and Prasad, S., 1982. Enzyme-linked immunosorbent assay of serum antibodies to Marek's disease virus in vaccinated chickens. Acta Virol., 26: 32.
Stucker, G., Schmidt, N.J., Forghani, B., Holmberg, C.A., Henrickson, R.V. and Anderson, J.H., 1979. Rotavirus antibody assay on monkey sera: a comparison of enzyme immunoassay with neutralization and complement fixation test. Amer. J. Vet. Res., 40: 1620-1623.
Suzuki, T., Ueda, S. and Samijima, T., 1982. Enzyme-linked immunosorbent assay for diagnosis of equine infectious anaemia. Vet. Microbiol., 7: 307-316.
Sytuo, B. and Matsumoto, M., 1981. Detection of chicken antibodies against avian encephalomyelitis virus by an enzyme-linked immunosorbent assay. Poult. Sci., 60: 1742.
Tadros, W., Haselhoff, W. and Laarman, J.N., 1979. The detection of circulating antibodies against sarcocystis in human and bovine sera by the enzyme linked immunosorbent assay (ELISA) technique. Acta Leidensia, 47: 53-63.
Taylor, S.M. and Kenny, H., 1978. The influence of concurrent infection with Oesophagostomum species on the interpretation of the ELISA test for trichinosis in pigs. Vet. Parasitol., 4: 257-260.
Taylor, S.M., Kilpatrick, D. and Kenny, J., 1978. The influence of age and husbandry of pigs on evaluation of the enzyme-linked immunosorbent assay (ELISA) for T. spiralis infection. Zbl. Vet. Med., 25B: 282-289.
Thoen, C.O., Blackburn, B., Mills, K., Lomme, J. and Hopkins, M.P., 1980a. Enzyme-linked immunosorbent assay for detecting antibodies in cattle in a herd in which anaplasmosis was detected. J. Clin. Microbiol., 11: 495-502.
Thoen, C.O., Hopkins, M.P., Armbrust, A.L., Angus, R.D. and Pietz, D.E., 1980b. Development of an enzyme linked immunosorbent assay for detecting antibody in sera of Brucella suis infected swine. Canad. J. Comp. Med., 44: 294-298.
Thoen, C.O., Mills, K. and Hopkins, M.P., 1980c. Enzyme-linked protein A: An enzyme linked immunosorbent assay reagent for detecting antibodies in tuberculous exotic animals. Amer. J. Vet. Res., 41: 833-835.
Todd, D., Adair, B.M. and Wibberley, G., 1980. An enzyme linked immunosorbent assay for enzootic bovine leukosis virus antibodies. Vet. Rec., 107: 124-126.

Todd, D., McNair, J., McNulty, M.S. and McFerran, J.B., 1981. Enzyme-linked immunosorbent assay for detection of antibodies to Aujeszky's disease virus in pig. Vet. Reg., 109: 534-537.

Ueda, Y., Sanai, Y. and Homma, J.Y., 1982. Enzyme-linked immunosorbent assay for detection of antibodies to Pseudomonas aeruginosa and measurement of antibody titre in horse serum. Amer. J. Vet. Res., 43: 55-60.

Voller, A., Bartlett, A. and Bidwell, D.E., 1978. Enzyme immunoassay with special reference to ELISA techniques. J. Clin. Path., 31: 507-521.

Waits, M.R., Reggiardo, C. and Meininger, A.C., 1982. Comparison of ELISA and FA test for the detection of feline leukemia virus. Southwest Vet., 34: 208-209.

Wardley, R.C., Abu-Elzein, E.M. E., Crowther, J.R. and Wilkinson, P.J., 1979. A solid phase enzyme-linked immunosorbent assay for detection of African swine fever antigen and antibodies. J. Hyg. (London), 83: 363-371.

Wright, P., Depauli, F.J. and Wilkie, B.N., 1980. Enzyme-linked immunosorbent assay for Aleutian disease virus antibody. Scientifur, 40: 41.

Yolken, R.H., Barbour, B., Wyatt, R.G., Kalica, A.R., Kapikian, A.Z. and Chanock, R.M., 1978. Enzyme-linked immunosorbent assay for identification of rotaviruses from different animal species. Science, 201: 259-262.

Yen, C.C. C., Yeh, J.M. and Chang, C.M., 1981. Evaluation of enzyme-linked immunosorbent assay (ELISA) in the serological diagnosis of toxoplasmosis in swine. J. Chin. Soc. Vet. Sci., 7: 35-41.

Young, E.R. and Purnell, R.E., 1980. Evaluation of dried blood samples as a source of antibody in the micro ELISA test for Babasia divergens. Vet. Rec., 106: 60-61.