

Identification of *Trichinella* spp. proteins recognized by specific IgG in serum of infected pigs by western blotting

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1 AIM AND FIELD OF APPLICATION

This document defines an immune-enzymatic method, western blotting, for the qualitative detection of anti-*Trichinella* spp. IgG in swine sera.

The method can be used as confirmatory test to screen pig populations on the exposure of swine to *Trichinella* spp. during sero-epidemiological surveys.

2 PRINCIPLE OF THE METHOD

Partially purified *Trichinella spiralis* excretory/secretory antigens are separated by SDS-PAGE electrophoresis. After running, proteins are transferred to a nitrocellulose membrane, which is then cut into 20 strips. Each strip is blocked with skimmed milk to saturate the sites free from antigens and singularly located in plastic trays.

Then strips are incubated with diluted control and test pig serum samples, allowing anti-*Trichinella* IgG that may be present in sera, to bind to the antigens on the nitrocellulose membranes.

The antibodies not binding to the antigens are eliminated by washing; goat anti-swine IgG conjugated with horseradish peroxidase (HRP) is then added to each strip. This second incubation allows the conjugate to bind to the swine antibodies that were bound to the antigens onto the strip surface.

The excess conjugate is eliminated by washing, and the activity of the enzyme HRP bound to the swine antibodies, is measured by adding a chromogen substrate. This allows to display a pattern of stained bands corresponding to those proteins that reacted specifically with anti-IgG antibodies to *Trichinella* spp., present in the pig serum (figure 1).

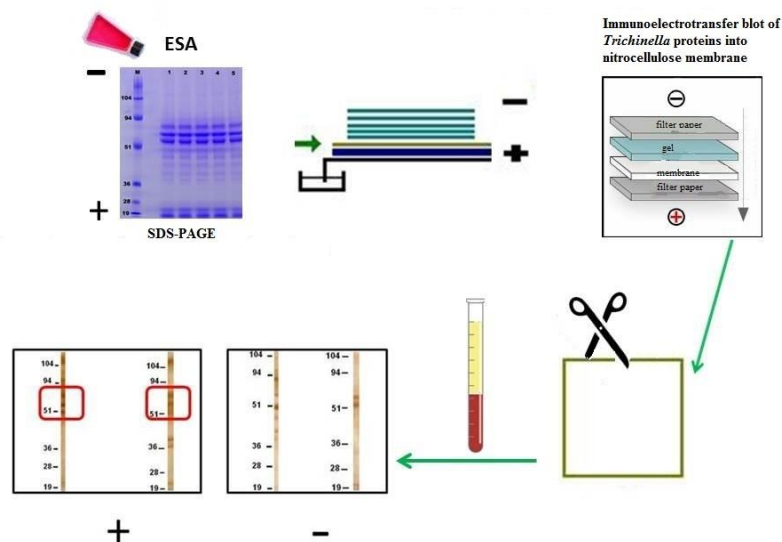


Figure 1. Schematic representation of the method

3 REFERENCES

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WHO Laboratory Biosafety Manual – Third Edition

(http://www.who.int/csr/resources/publications/biosafety/WHO_CDS_CSR_LYO_2004_11/en/).

4 DEFINITIONS

4.1 Acronyms

Ag	Antigen
Ab	Antibody
Ag E/S	Excretory/secretory antigens
BSA	Bovine serum albumin
Wb	Western blotting

5 DEVICES/INSTRUMENTS

- 5.1 Power supplies
- 5.2 Thermomixer
- 5.3 pH meter
- 5.4 Analytical balance or technical balance
- 5.5 Refrigerator, 1÷8°C
- 5.6 Freezer, ≤ - 50°C
- 5.7 Freezer, ≤ -15°C
- 5.8 Magnetic stirrer
- 5.9 Vortex mixer
- 5.10 Micropipettes (0.5-10 µL, 5-100 µL, 15-300 µL)
- 5.11 Water analytical grade
- 5.12 Dispenser Multipette Eppendorf®
- 5.13 Combitips devices for Multipette Eppendorf®
- 5.14 Tray X Cell SureLock Mini-cell for vertical electrophoresis
- 5.15 Mini Trans-Blot Module Biorad

6 REAGENTS AND CHEMICALS

Electrophoresis

6.1 Preparation of the test and control sample for electrophoretic run

Ag E/S	100 µg
NuPAGE LDS Sample Buffer (4X)	50 µL
NuPAGE Reducing Agent(10X)	20 µL
Analytical Grade water	up to 200 µL

Stir using a magnetic stirrer until completely dissolved .

6.2 Gel, for electrophoresis :

NuPAGE Novex 10% Bis-Tris Mini Gels 1.0mm X2D well Invitrogen

6.3 Prestained molecular weight markers:

Prestained SDS-PAGE Standards Low range Biorad 10 µL

6.4 Antioxidant : NuPAGE

500 µL

6.5 Running Buffer:

Mops SDS Running Buffer (20X) 50mL
Analytical grade water up to 1000mL

The solution must be used within 1 month.

6.6 Transfer Buffer:

Tris-Glycine (25X) 40mL
Metanol 200mL
Analytical grade water up to 1000mL
The solution must be used within 1 month

6.7 Nitrocellulose membrane 0,2 µm

6.8 Ponceau S Solution

20 mL

6.9 Mini-Incubation Trays

Western blotting

6.10 TTBS Buffer

Tween 20	1 mL
Tris 0,2 M	2,4 g
NaCl 3M	17,5 g
Analytical grade water	fino a 2000mL

The solution must be used within 6 months

Dissolve the compounds in about 1000 mL of analytical grade water under magnetic stirring. Check the pH (7.8 ± 0.2) and then bring the solution to the final volume; store at 1÷ 8°C.

6.11 Sera and conjugate diluter

Skimmed milk powder	1,5 g
TTBS Buffer (pH 7,4)	

The solution should be prepared immediately before use, as follows: place 1,50 g skimmed milk directly in a 50 mL tube; add 40 ml of TTBS buffer and mix by vortexing until milk is completely dissolved and bring it to volume. If refrigerated, the solution must be used within 24 h.

6.12 Washing solution

TTBS Buffer (6.10) 2000 mL

6.13 Blocking solution
Skimmed milk powder 2,5 g
TTBS Buffer 50 mL

The solution should be prepared immediately before use, as follows: place 2,5 g skimmed milk directly in a 50 mL tube; add 40 mL of TTBS buffer and mix by vortexing until the milk is completely dissolved and bring to volume. If refrigerated, the solution must be used within 24 h.

6.14 Phosphate buffered saline (PBS), pH 7.3 ± 0.2
KH₂PO₄ 0.34 g
Na₂HPO₄ 1.21 g
NaCl 8.0 g
Analytical grade water up to 1000 mL

Dissolve compounds in 750 mL of analytical grade water under magnetic stirring. Check the pH (7.3 ± 0.2) and then bring the solution to the final volume; refrigerate. If refrigerated, the solution must be used within 6 months.

6.15 Anti-*Trichinella* spp. IgG positive control sera (positive controls).

Sera collected at day 60 p.i. from pigs experimentally infected with *Trichinella* spp

6.16 Anti-*Trichinella* sp. negative control sera.(negative controls).

6.17 Chromogenic DAB (3, 3'diaminobenzidina).

Dissolve a DAB tablet in 15 mL of PBS (6.14). Mix by vortexing until the DAB is completely dissolved (5.9).

6.18 Hydrogen peroxide

Add to chromogenic (6.18) immediately before use 12 μ L

6.19 Peroxidase labeled (horseradish peroxidase) anti-swine IgG goat antibodies .

If the reagent is freeze-dried , it shall be rehydrated before using, by vortexing with analytical grade water (5.9) until completely dissolved. Once rehydrated, the conjugate can be stored refrigerated (5.5) to $1 \div 8^{\circ}$ C for one week.

To determine the optimal working dilution of the conjugate (that is, the dilution which displays the specific bands in positive controls with a minimum of background staining), the working dilutions recommended by the manufacturer are tested. If none of these dilutions result optimal, the further dilutions of the reagent shall be tested until the optimal one is obtained.

The conjugate should be aliquoted and stored frozen (5.6) at $<-50^{\circ}$ C. In these conditions it remains stable for at least 5 years. Before testing, an aliquot of conjugate must be diluted to the optimum concentration with the dilution solution (6.11). Once diluted, store the conjugate refrigerated (5.5) at 1 to 8° C and use within 24 hours.

7 PROCEDURE

7.1 Samples and marker preparation

Use 100 μ g of Ag E/S for a gel and add all reagents (6.1). Stir using a magnetic stirrer (5.8) until complete dissolution. Incubate 10' at 70° C in the Thermomixer (5.2). Take an aliquot of the molecular weight markers (6.3) containing 10 μ l and incubate 1' to 40° C in the heating block (5.2).

7.2 SDS-PAGE

Put 1 or 2 gels (6.2) in the electrophoresis tray (5.14) for vertical electrophoresis (Figure 2). Fill half of the electrophoresis tray (about 500 ml) with running buffer (6.5). Add 200 ml of running buffer with 500 µl of antioxidant in the central part of the tray (6.4).

Load the proteins in the gel by micropipette (5.10), connect the electrophoresis tray to the electrophoresis power supply (5.1) and allow the separation of the proteins by applying 150 V for 1h at room temperature (RT).

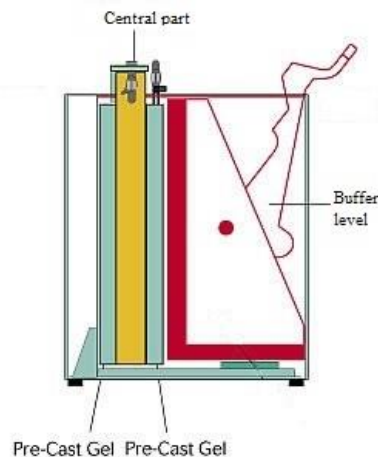


Figure 2. Representation of the vertical electrophoresis cassette.

7.3 Transfer to nitrocellulose membranes

At the end of the electrophoresis running, put the gel containing the proteins on a nitrocellulose membrane (6.7), according to the scheme of the Mini Trans-Blot Module Biorad (5.15) shown in the figure 3.

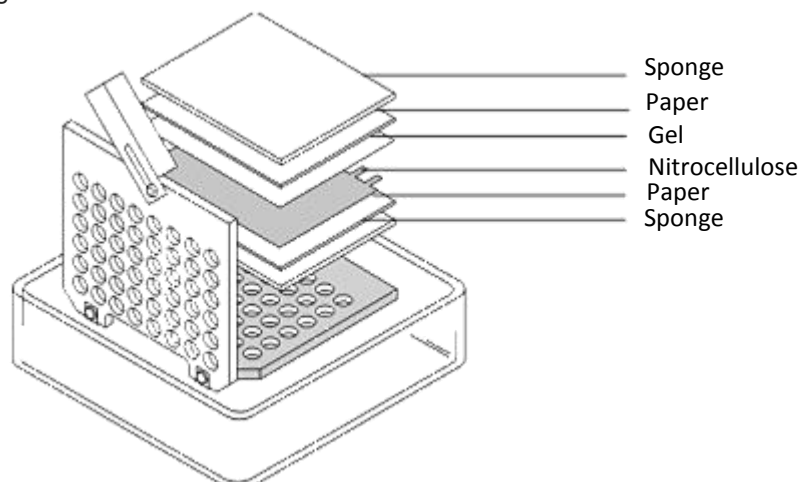


Figure 3. Scheme of the transfer from gel to nitrocellulose membrane protein.

Place the assembled system in the X cell SureLock (Figure 4) with transfer buffer (6.6) and ice block, connect the power supply unit (5.1) for 1 h at + 4°C at 38 mA (5.15), so that proteins migrate from the gel, to the nitrocellulose.

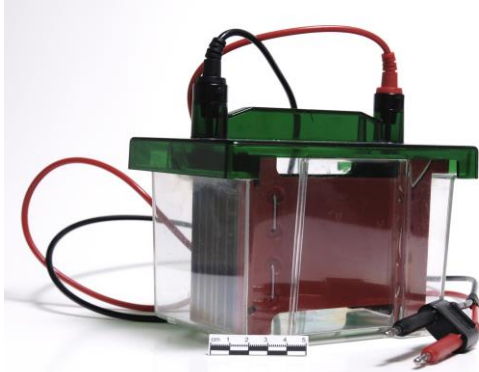


Figure 4. X cell SureLock protein transfer

7.4 Verification of proteins transfer

At the end of the transfer open the cassette, remove the nitrocellulose and place it in a tray with dye (6.8) in order to verify the effective transfer. Wash with tap water to remove excess dye and cut the filter in strips using a scalpel.

7.5 Nitrocellulose blocking

Strips are put in the blocking solution (6.13) overnight at +4°C. Then, strips are washed with TTBS buffer (6.10). The strips are left to dry, then can be stored at RT up to two months wrapped in filter paper.

7.6 Test and control samples preparation

Defreeze the test and positive and negative control sera by storing at +1-8°C for at least 5 h.

Once thawed, keep them in an ice bath and stir them by vortexing before use.

Dilute 1:100 the test and control sera as follows: in a 1-2 mL conical bottom tube add 10 µL of serum and 990 µL diluting solution (6.11). Diluted sera can be stored refrigerated (5.5) for up to 24 hs.

7.7 Analytical method.

- a. Bring out the serum samples from the refrigerator.
- b. Dispose the nitrocellulose strips in the appropriate Mini-Incubation Trays (6.9) and wash them with TTBS (6.10) for 5' at RT.
- c. Incubate the control and test sera for 1 hour at RT.
- d. Wash 3 times for 5' at RT with TTBS solution (6.10).
- e. Incubate the diluted conjugate (6.11) 1h at RT
- f. Wash 3 times for 5' at RT with TTBS solution (6.10).
- g. Add the chromogenic (6.18) until you see the bands.
- h. Stop reaction with tap water

8 INTERPRETATION OF THE RESULTS

The electrophoretic separation of the proteins of *T. spiralis* and their subsequent transfer on nitrocellulose membrane are considered valid when all the markers (or standards) of molecular weight (MW) colored, used in each gel, were:

- electrophoretically separated,
- transferred to nitrocellulose membrane.

Furthermore, the relative mobility of each standard shall be in the range previously established by means of three independent experiments. For standard of 104 proteins, 94, 51, 36, 28 and 19 kD, the relative mobility are: 0:13, 0:24, 0:41, 0.66, 0.80, 0.91mm, respectively (S.D. ± 0.2 ; Figure 5); for the positive control, see the relative mobility as previously published (Gomez Morales et al., 2014, with S.D. ± 0.2).

If even one relative mobility is not within the specific range, the results shall be considered invalid and the test has to be repeated.

The specific *T. spiralis* E/S proteins reacting with the reference and test sera from pigs, are identified by calculating their molecular weight (MW) as follows (Figure 5):

1. in a Microsoft Word Excel electronic sheet trace a PM log graph of pre-stained standards to their relative migration distance (Rf);
2. interpolate the Rf of *T. spiralis* specific E/S proteins which react with pig test and reference sera, to calculate their molecular weights;
3. the specific proteins that react with pig sera, both reference and test sera, must show a triple-band pattern in a region comprised between 48 and 72 kDa (the first band from 48 kDa to 55 kDa, the second band from 59 kDa to 62 kDa and the third band from 64 to 72 kDa).

	A	B	C	D	E	F	G	H	I
1	MW (kD) of the prestained molecular marker proteins	Migration distance (cm) of the prestained molecular marker proteins			Rf prestained molecular marker proteins			Rf Mean	Log MW
2		experiment 1	experiment 2	experiment 3	experiment 1	experiment 2	experiment 3	x	y
3	104	0,6	0,9	0,7	=PRODUCT(B3;1/B10)	=PRODUCT(C3;1/C10)	=PRODUCT(D3;1/D10)	=MEAN(E3;G3)	=LOG10(A3)
4	94	1,2	1,5	1,3	=PRODUCT(B4;1/B10)	=PRODUCT(C4;1/C10)	=PRODUCT(D4;1/D10)	=MEAN(E4;G4)	=LOG10(A4)
5	51	2,2	2,5	2,3	=PRODUCT(B5;1/B10)	=PRODUCT(C5;1/C10)	=PRODUCT(D5;1/D10)	=MEAN(E5;G5)	=LOG10(A5)
6	36	3,6	3,8	3,7	=PRODUCT(B6;1/B10)	=PRODUCT(C6;1/C10)	=PRODUCT(D6;1/D10)	=MEAN(E6;G6)	=LOG10(A6)
7	28	4,4	4,7	4,5	=PRODUCT(B7;1/B10)	=PRODUCT(C7;1/C10)	=PRODUCT(D7;1/D10)	=MEAN(E7;G7)	=LOG10(A7)
8	19	5	5,2	5,1	=PRODUCT(B8;1/B10)	=PRODUCT(C8;1/C10)	=PRODUCT(D8;1/D10)	=MEAN(E8;G8)	=LOG10(A8)
9									
10		5,5	5,8	5,6					
11	Migration distance of the front								
12									
13		Migration distance of the unknown proteins			Rf unknown proteins			Rf Mean	Log MW
14									
15		1,8	2,1	1,9	=PRODUCT(B15;1/B10)	=PRODUCT(C15;1/C10)	=PRODUCT(D15;1/D10)	=MEAN(E15;G15)	=TREND(I3:I8;H3:H8;H15;TRUE)
16		2,2	2,4	2,3	=PRODUCT(B16;1/B10)	=PRODUCT(C16;1/C10)	=PRODUCT(D16;1/D10)	=MEAN(E16;G16)	=TREND(I3:I8;H3:H8;H16;TRUE)
17		2,5	2,8	2,6	=PRODUCT(B17;1/B10)	=PRODUCT(C17;1/C10)	=PRODUCT(D17;1/D10)	=MEAN(E17;G17)	=TREND(I3:I8;H3:H8;H17;TRUE)
18									
19									
20									=POWER(10;I15)
21									=POWER(10;I16)
22									=POWER(10;I17)

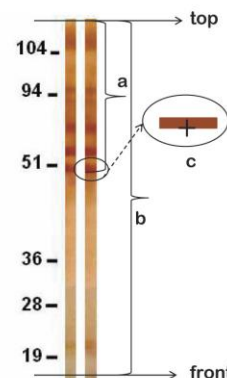
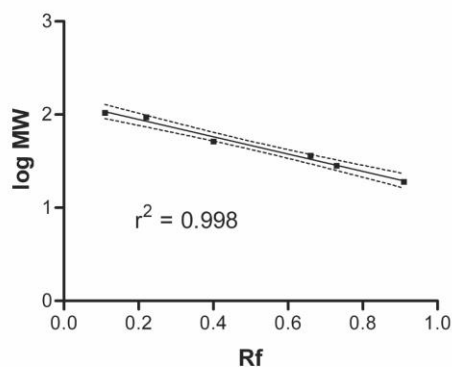


Figure 5. The above table shows the results of experiments carried out to determine the relative mobility of each molecular weight marker. The graph on the left shows the regression line of the

relative distance of the reference sera as a function of their molecular weight. The graph on the right shows the pattern of specific proteins and the E/S Ag of *T. spiralis* which react with pig sera in Wb.

9 CHARACTERISTICS OF THE METHOD

This method has been characterized in terms of sensitivity, specificity and reproducibility. The results were used to confirm that the method is suitable for the intended purpose and are reported in the relevant validation file, to which reference is made.

10 SAFETY MEASURES

This test method can be performed only by experienced personnel. As potentially infected sera with zoonotic pathogens are handled, analysts are provided with personal protective equipment, such as disposable gloves and lab coats. For safety measures to be adopted during testing, refer to the WHO Laboratory Biosafety Manual – Third Edition (http://www.who.int/csr/resources/publications/biosafety/WHO_CDS_CSR_LYO_2004_11/en/).