Identification of *Trichinella* spp. proteins recognized by specific IgG in serum of humans with trichinellosis 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 human sera.

The method shall be used as confirmatory test for the serological diagnosis of human trichinellosis.

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 human 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-human IgG conjugated with horseradish peroxidase (HRP) is then added to each strip. This second incubation allows the conjugate to bind to the human 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 human 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 human serum (figure 1).

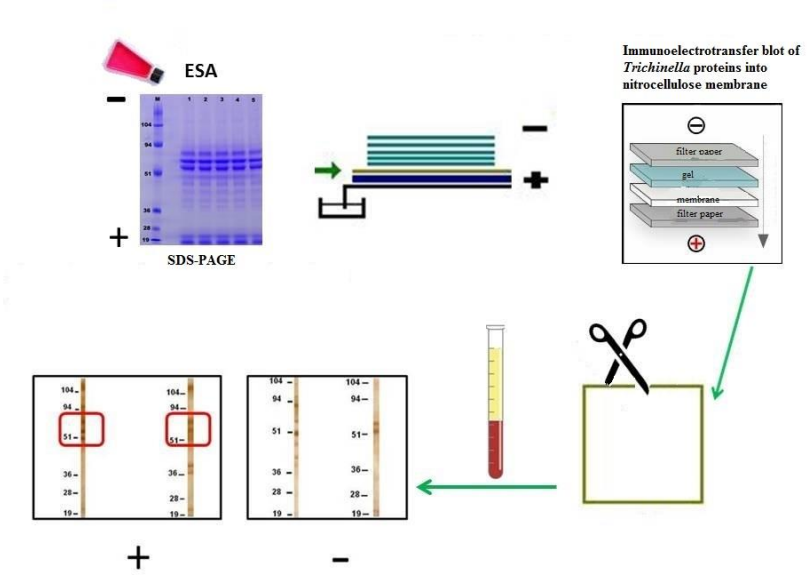

Figure 1. Schematic representation of the method

3 REFERENCES

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4 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 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, 50-1000 µL)
5.11 Water analytical grade
5.12 Tray X Cell SureLock Mini-cell for vertical electrophoresis
5.13 Mini Trans-Blot Module Biorad
5.14 Scalpel
5.15 Pipette aid
5.16 Serological pipettes

6 REAGENTS AND CHEMICALS

<u>Electrophoresis</u>

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 Electrophoresis gel

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

Use the solution within 1 month.

6.6 Transfer Buffer:

Tris-Glycine (25X)	40mL
Metanol	200mL
Analytical grade water	up to 1000mL

Use the solution 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 TBS Buffer

Tris 0,2 M	2.4 g
NaCl 3M	17.5 g
Analytical grade water	up to 2000mL

Use the solution 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 TTBS Buffer

Tween 20	1 mL
Tris 0,2 M	2.4 g
NaCl 3M	17.5 g
Analytical grade water	up to 2000mL

Use the solution 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.

6.12 Sera and conjugate diluter

Skimmed milk powder	1.5 g
TTBS Buffer (pH 7,4)	up to 50 mL

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, use the solution within 24 h.

6.13 Washing solution

TTBS Buffer (6.11)	2000 mL

6.14 Blocking solution

Skimmed milk powder	2.5 g
TTBS Buffer	50 mL

Prepare the solution 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, use the solution within 24 h.

6.15 Phosphate buffered saline (PBS), pH 7.3±0.2

KH_2PO_4	0.34 g
Na_2HPO_4	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, use the solution within 6 months.

6.16 Sera from *Trichinella* sp. infected individuals (positive controls).

6.17 Sera from *Trichinella* sp. free individuals that resulted suitable for blood donation according to the Italian low (3 March 2005 DM) protocols (negative controls).

6.18 Chromogenic DAB (3, 3'diaminobenzidina).

Dissolve a DAB tablet in 15 mL of PBS (6.15). Mix by vortexing (5.9) until the DAB is completely dissolved.

6.19 Hydrogen peroxide

Add to chromogenic (6.18) immediately before use 12 µL

6.20 Conjugate: peroxidase labeled (horseradish peroxidase) anti–human IgG goat antibodies

The conjugate can be stored refrigerated (5.5) to 1÷8°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 results optimal, the further dilutions of the reagent shall be tested until the optimal one is obtained. Before testing, conjugate must be diluted to the optimum concentration with the dilution solution (6.12). Once diluted, store the conjugate refrigerated (5.5) to 1÷8°C and use within 24 hours.

7 PROCEDURE

7.1 Samples and marker preparation

Use 100µg 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 a 10µl aliquot of the molecular weight markers (6.3) and incubate 1' to 40°C in the heating block (5.2).

7.2 Gel electrophoresis loading

Put one or two 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).

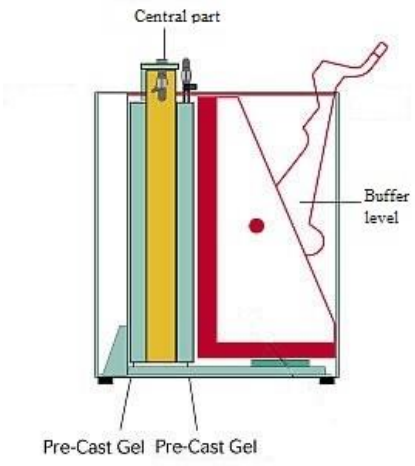


Figure 2. Representation of the vertical electrophoresis cassette.

7.3 Transfer to nitrocellulose membrane

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.

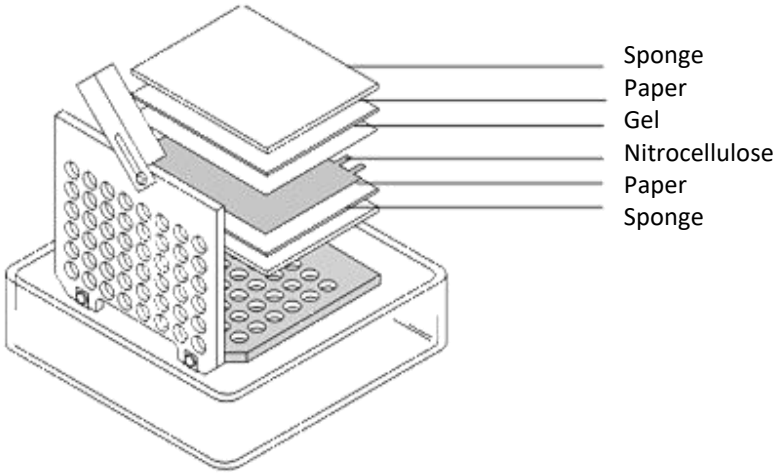


Figure 3. Scheme of the transfer from gel to nitrocellulose membrane protein

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.

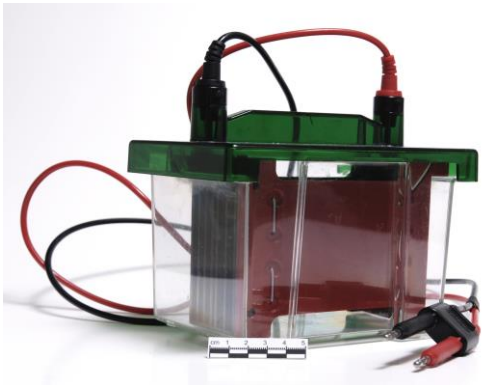


Figure 4. X cell SureLock protein transfer

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

Put the strips in the blocking solution (6.14) overnight at +4°C. Then, wash the strips with TTBS buffer (6.11). Once the strips are dried, can be stored at RT up to two months wrapped in filter paper.

7.6 Test and control samples preparation

Thaw the test sera, 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 dispense 1 mL of diluting solution with a serological pipette placed on a pipettor and discard 10 µL through a micropipette. Alternatively, dispense 990 µL diluting solution with a micropipette and add 10 µL of serum. 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 (6.11) 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 (6.11).
e. Incubate the diluted conjugate (6.12) 1h at RT
f. Wash 3 times for 5' at RT with TTBS solution (6.11).
g. Wash 1 time for 5' at RT with TBS solution (6.10).
h. Add the chromogenic (6.18) until you see the bands.
i. 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.

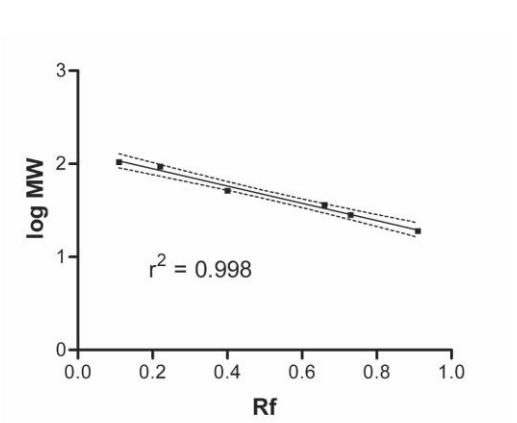
Furthermore, the relative mobility of each standard shall be in the range previously established by means of three independent experiments. For standard of 104 proteins, 94, 51, 36, 28 and 19 kD, the relative mobility are: 0.13, 0.24, 0.41, 0.66, 0.80, 0.91, respectively (S.D. $\pm$ 0.2; Figure 5); for the positive control, see the relative mobility as previously published (Gomez Morales et al., 2012, with S.D. $\pm$ 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 humans, 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); then the correlation coefficient (r^2) have to be calculated, it has to be in the range 0.75-1 (Colton, 1988),
2. interpolate the Rf of *T. spiralis* specific E/S proteins which react with human test and reference sera, to calculate their molecular weights;
3. the specific proteins that react with human sera, both reference and test sera, must show a triple-band pattern in a region comprised between 53 and 72 kDa (the first band from 53 kDa to 55 kDa, the second band from 59 kDa to 62 kDa and the third band from 67 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	Migration distance of the front	5,5	5,8	5,6					
11									
12									
13		Migration distance of the unknown proteins							
14					Rf unknown proteins			Rf Mean	Log MW
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							Molecular weight of the unkown proteins		=POWER(10;I16)
22									=POWER(10;I17)



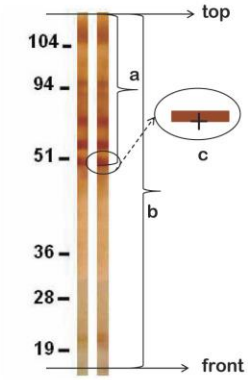


Figure 5. The above table shows the results of experiments carried out to determine the relative mobility of each molecular weight marker. The graph on the left shows the regression line of the relative distance of the reference sera as a function of their molecular weight. The graph on the right shows the pattern of specific proteins and the E/S Ag of *T. spiralis,* which react with human 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/)