Effect of Electrolyzed Water for Reduction of Foodborne Pathogens on Vegetables

Introduction

1. Fresh produce is an essential part of the diets of people around the world and consumption of fresh-cut produce has increased in recent

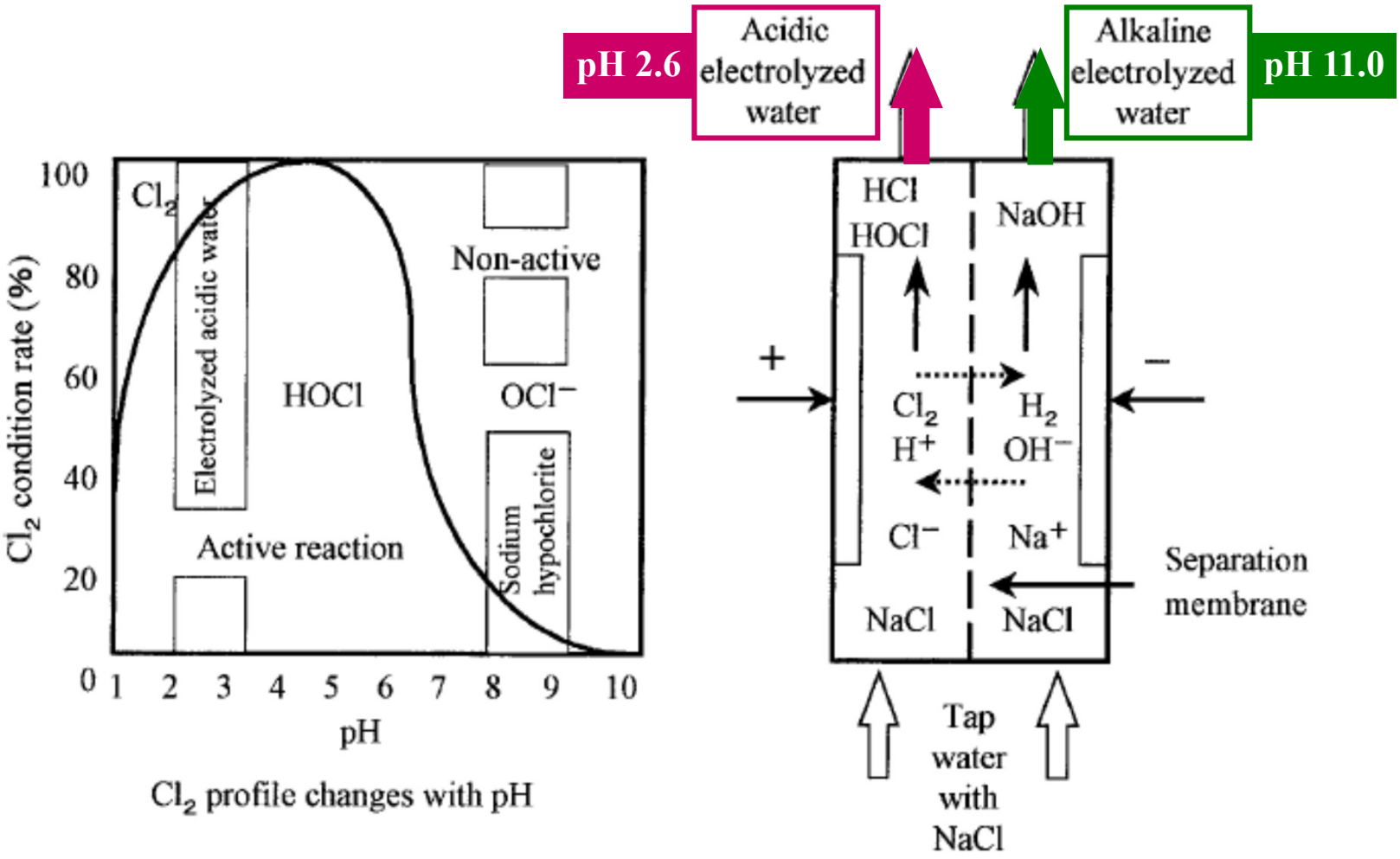
2. Pathogens can contaminate fresh produce through agricultural practices and survive during processing and distribution

3. Consumer demand for more natural, less toxic alternatives has lead industry to develop a number of novel fresh produce sanitizers

4. More effective and natural sanitizers to reduce pathogenic microorganisms on fresh fruits and vegetables are needed

5. **Electrolyzed water** is produced from pure water and sodium chloride

Principle of Electrolyzed Water



Reference : Bari et al. 2003. Effectiveness of electrolyzed acidic water in killing *Escherichia coli* O157:H7, *Salmonella* Enteritides, and *Listeria monocytogenes* on the surface of tomatoes. *J. Food Prot.* 66(4):542-548

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Materials and Methods

1. Sample preparation and inoculation

Escherichia coli O157:H7 (ATCC 35150, ATCC 13311, and ATCC 14028)

Salmonella Typhimurium (ATCC 19585, ATCC 13311, and ATCC 14028)

Listeria monocytogenes (ATCC 19114, ATCC 19113, and ATCC 7644)

→ 0.1 mL of each pathogen cocktail was applied to **leaf surfaces**

(25 g of **lettuce, spinach, green onions, tomatoes**)

2. Electrolyzed Water (EW) preparation

EW was prepared by subjecting **0.1% sodium chloride** solution

→ electrolysis for 15 min using a Super Oxide Series II electrolyzed water generator (Proton Lab., Portland, OR, USA)

Materials and Methods

3. Treatment of lettuce and spinach with EW

- Deionized Water (**DI**)
- Acidic Electrolyzed Water (**AcEW**)
- Alkaline Electrolyzed Water (**AlEW**)
- **AlEW** (10 sec) **+ AcEW** (sequential treatment)
- **DI** (10 sec) **+ AcEW** (sequential treatment)

Treatment time

- **15 sec**
- **30 sec**
- **1 min**
- **3 min**
- **5 min**

4. Enumeration of microorganisms

- *Escherichia coli* O157:H7 : Sorbitol MacConkey agar (SMAC; Difco)
- *Salmonella* Typhimurium : Xylose Lysine Desoxycholate agar (XLD; Difco)
- *Listeria monocytogenes* : Oxford Agar Base (OAB; Difco)

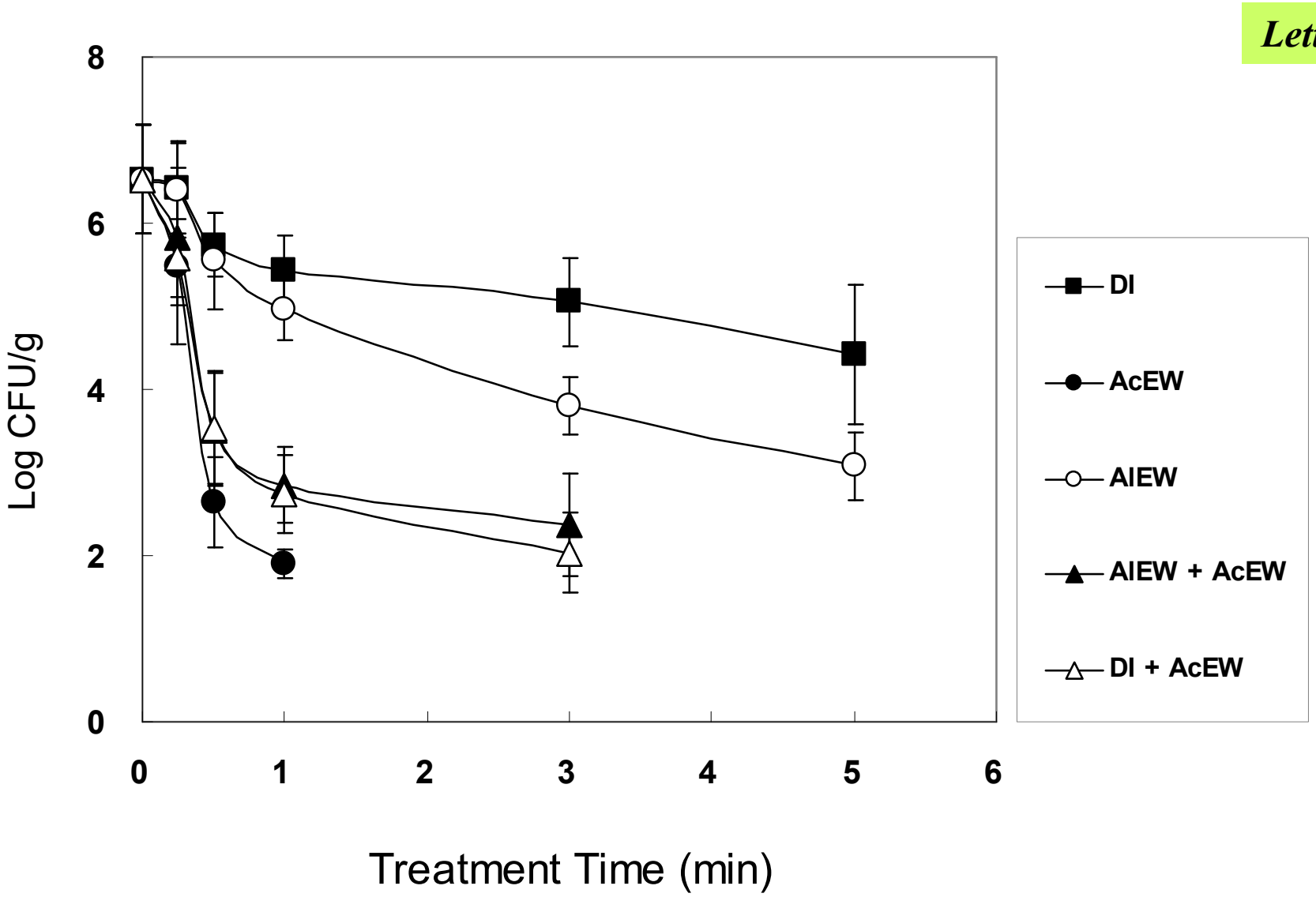


FIGURE 1.
Survival curves for ***Escherichia coli* O157:H7** on lettuce leaves exposed to EW

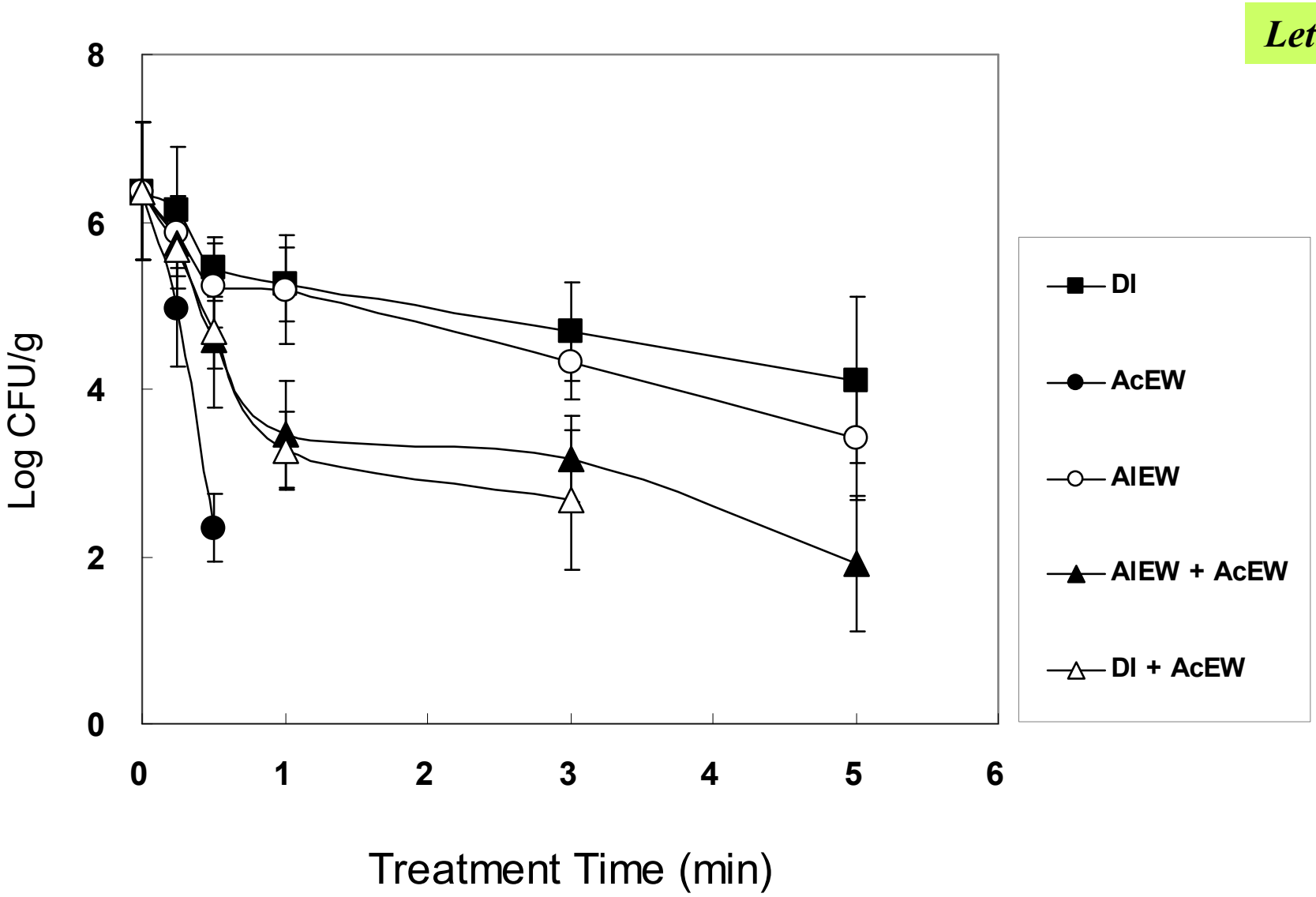


FIGURE 2.
Survival curves for ***Salmonella*** **Typhimurium** on lettuce leaves exposed to EW

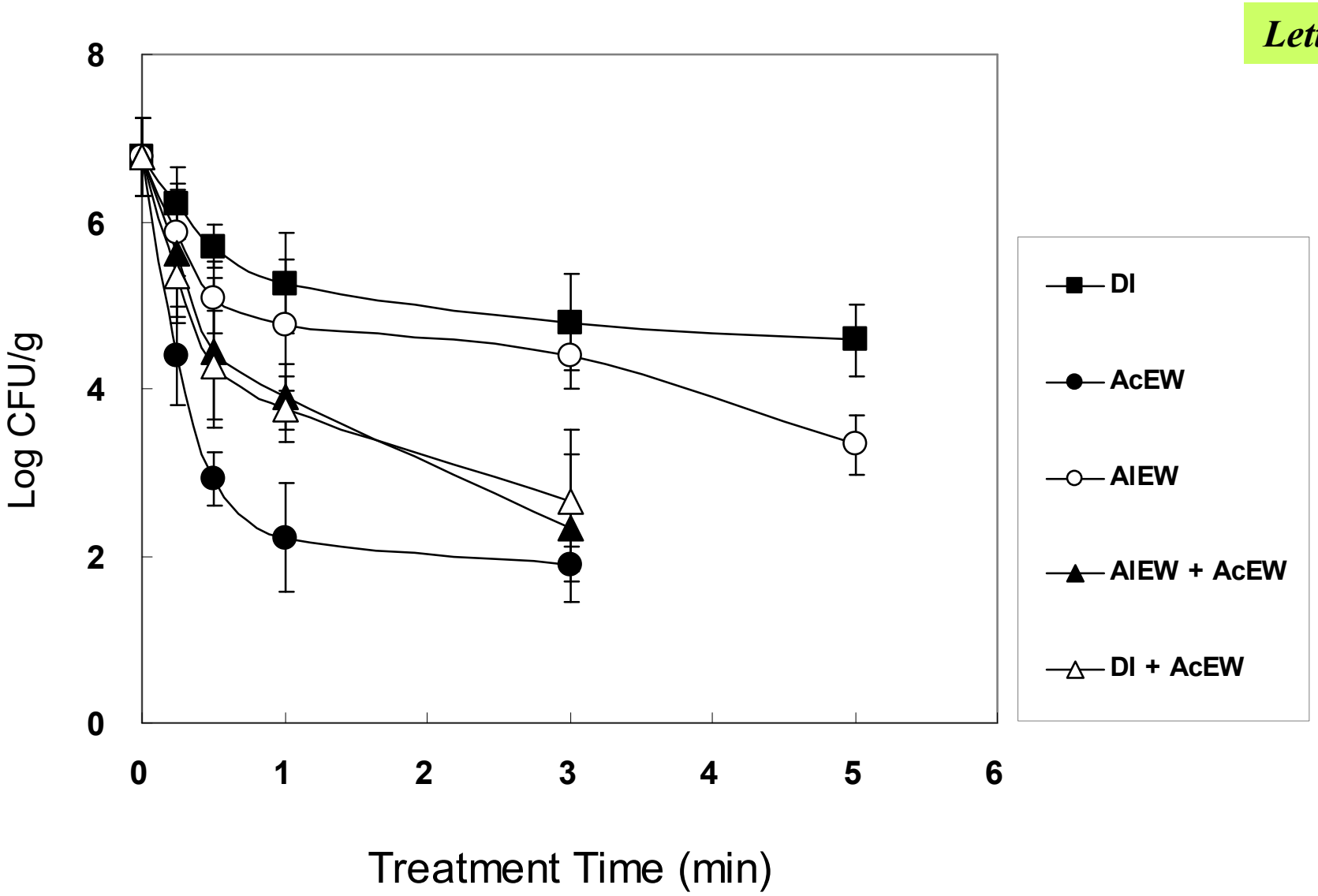


FIGURE 3.
Survival curves for ***Listeria monocytogenes*** on lettuce leaves exposed to EW

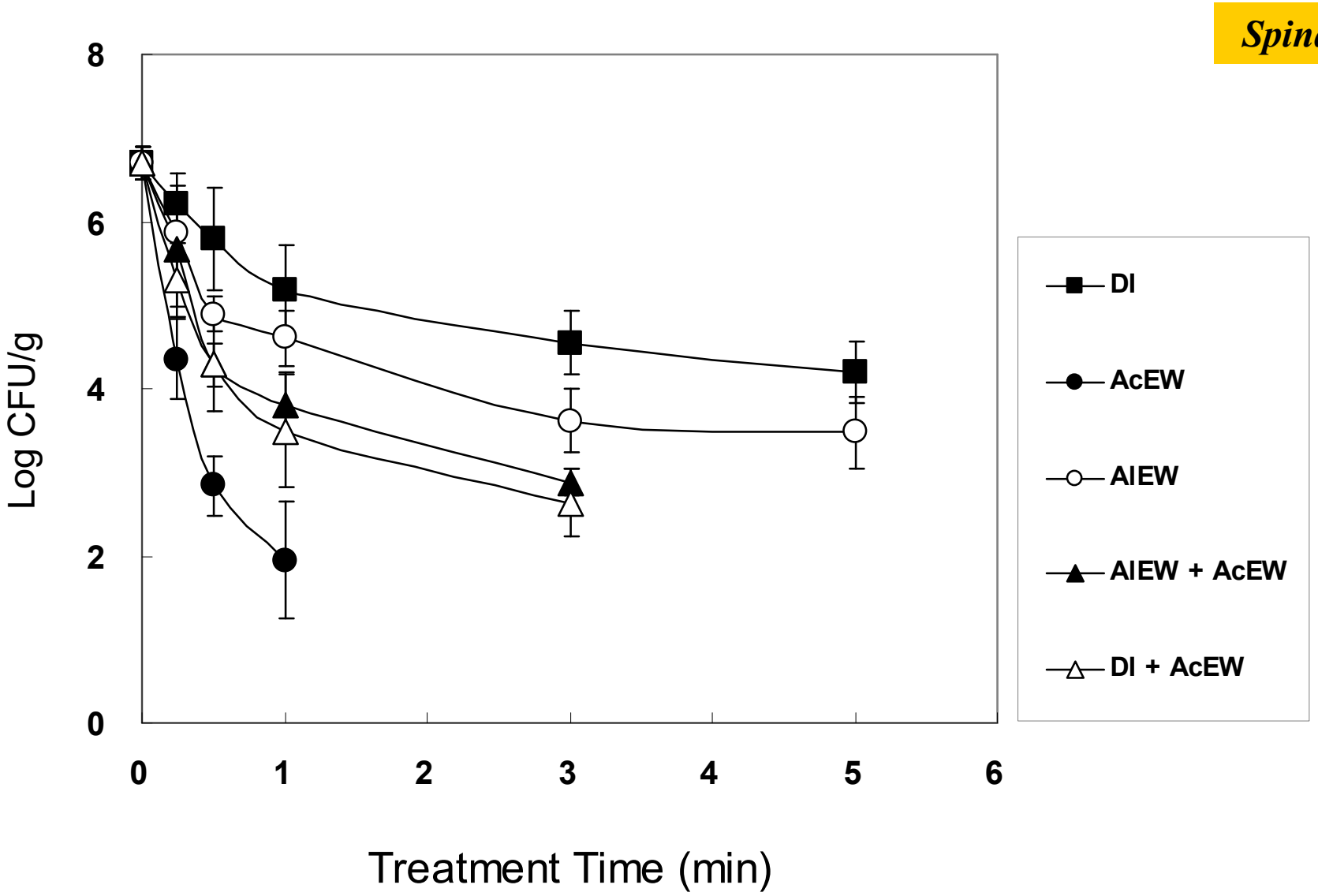


FIGURE 4.
Survival curves for ***Escherichia coli* O157:H7** on spinach leaves exposed to EW

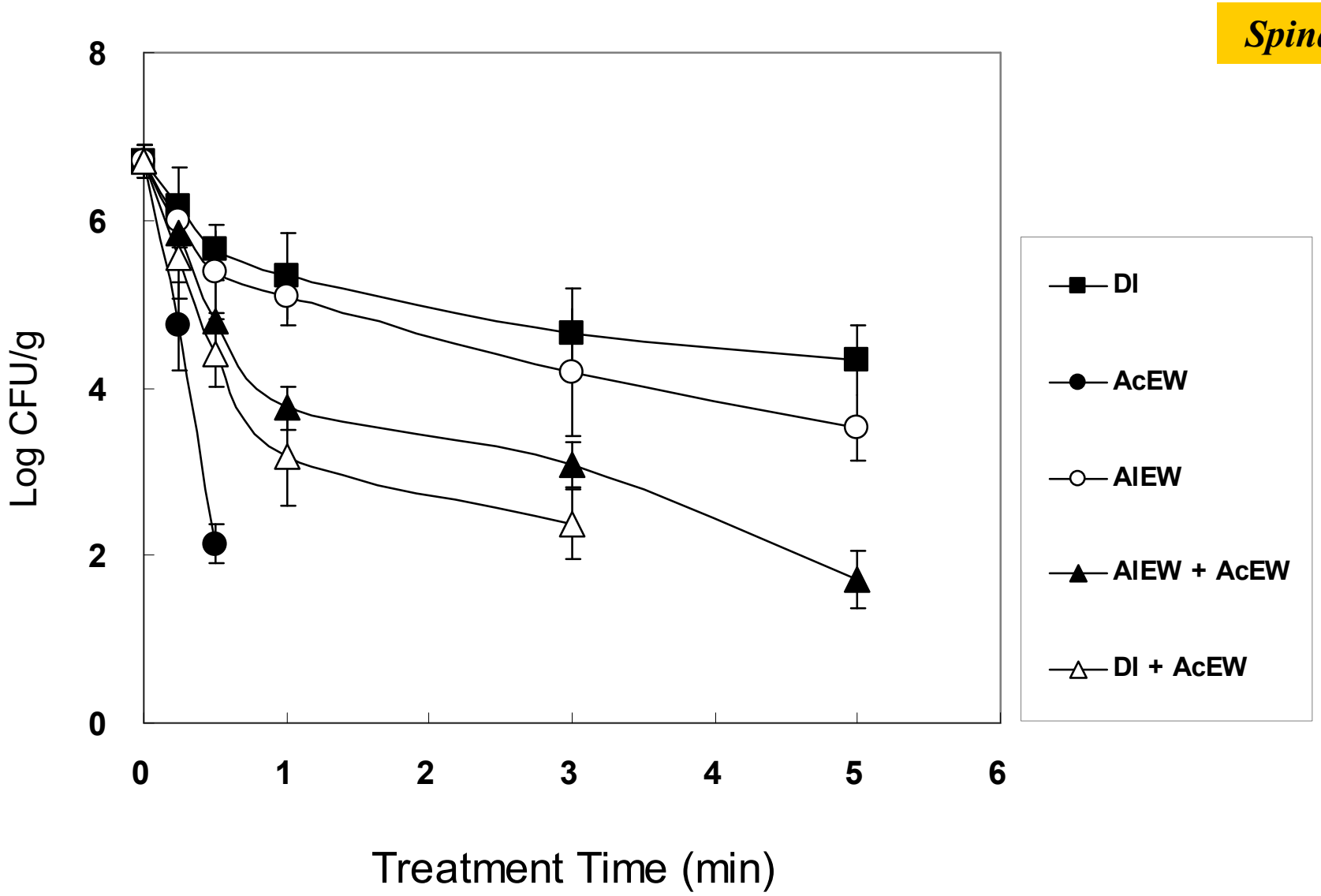


FIGURE 5.
Survival curves for ***Salmonella*** **Typhimurium** on spinach leaves exposed to EW

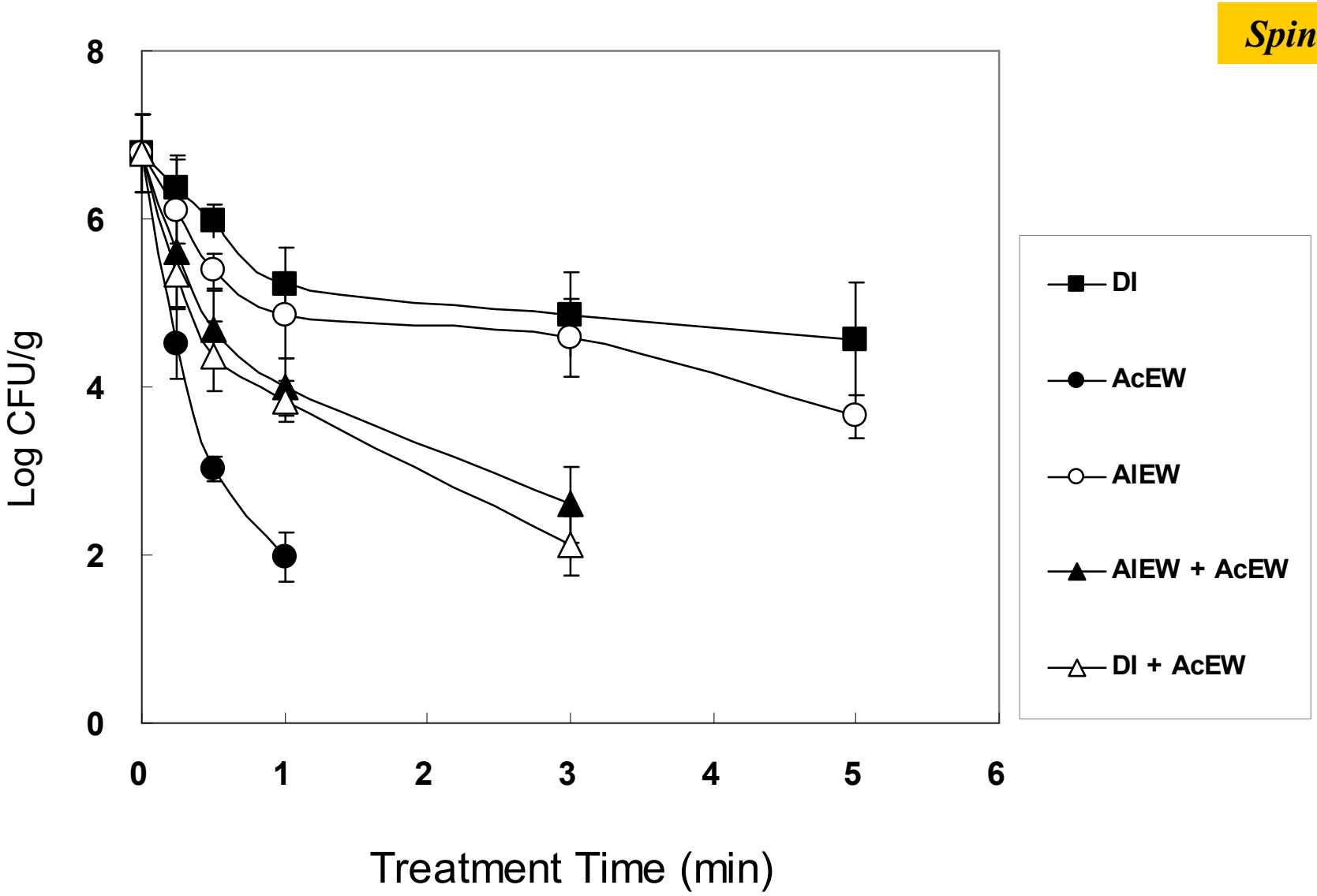


FIGURE 6.
Survival curves for ***Listeria monocytogenes*** on spinach leaves exposed to EW

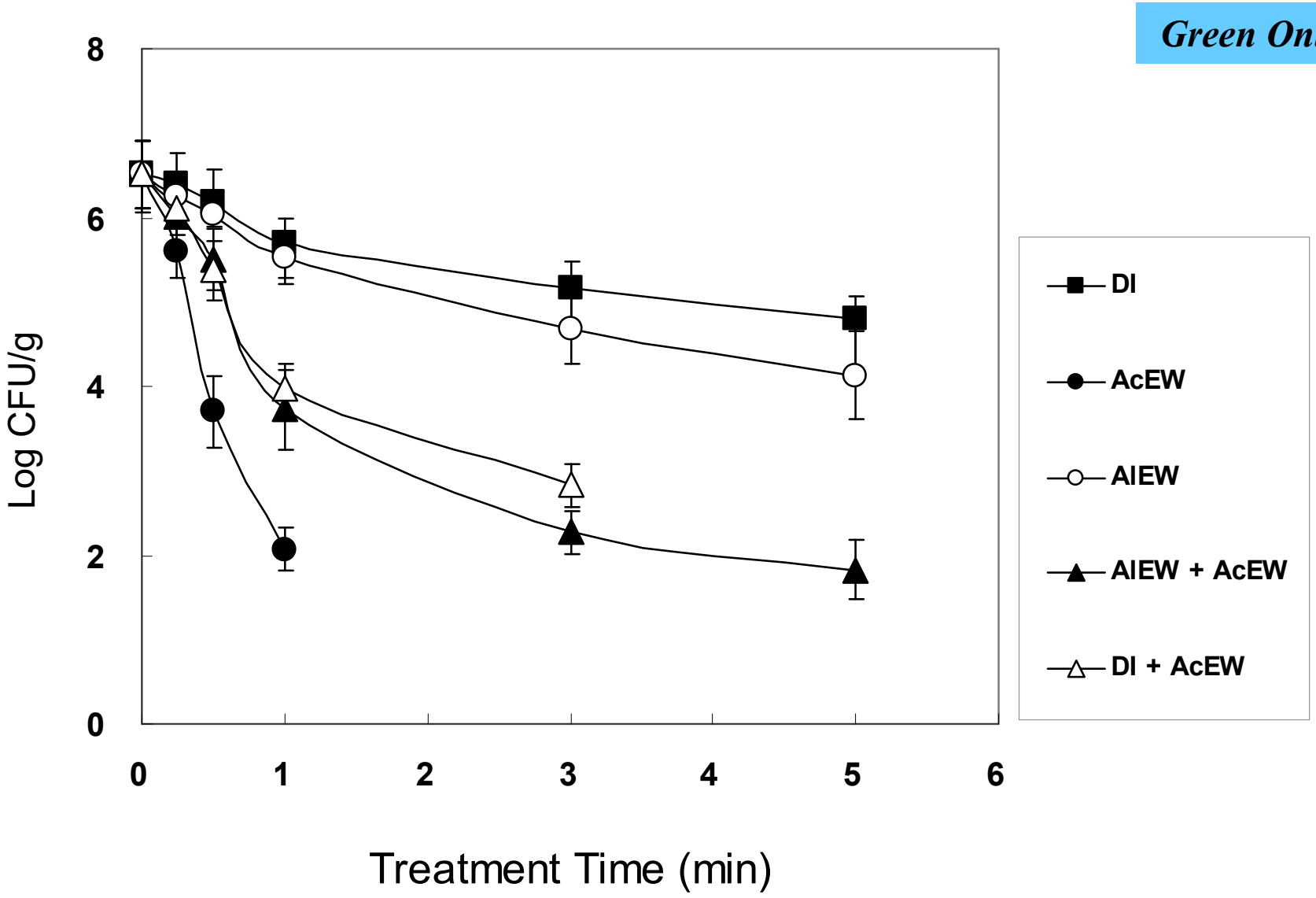


FIGURE 7.
Survival curves for ***Escherichia coli* O157:H7** on green onions exposed to EW

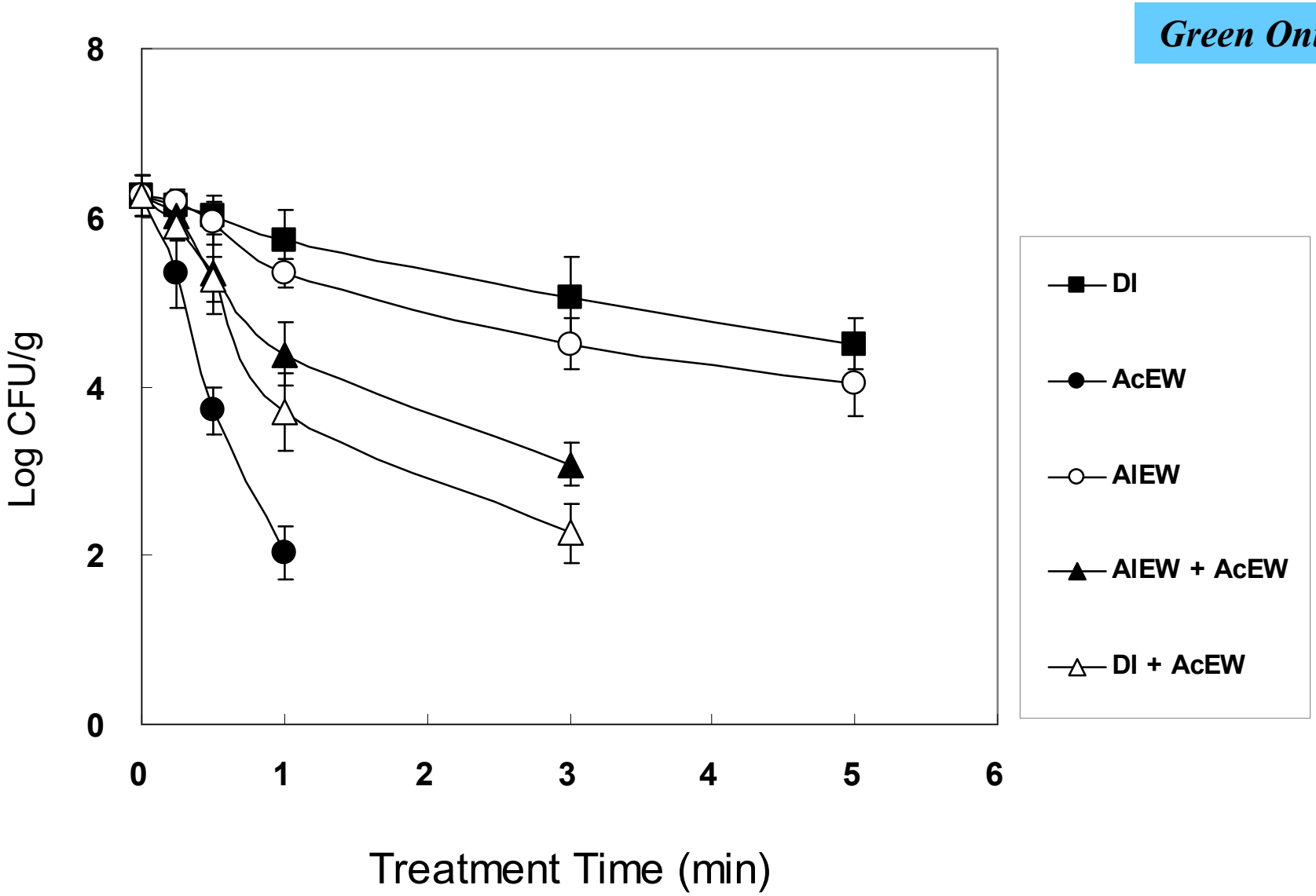


FIGURE 8.
Survival curves for ***Salmonella*** **Typhimurium** on green onions exposed to EW

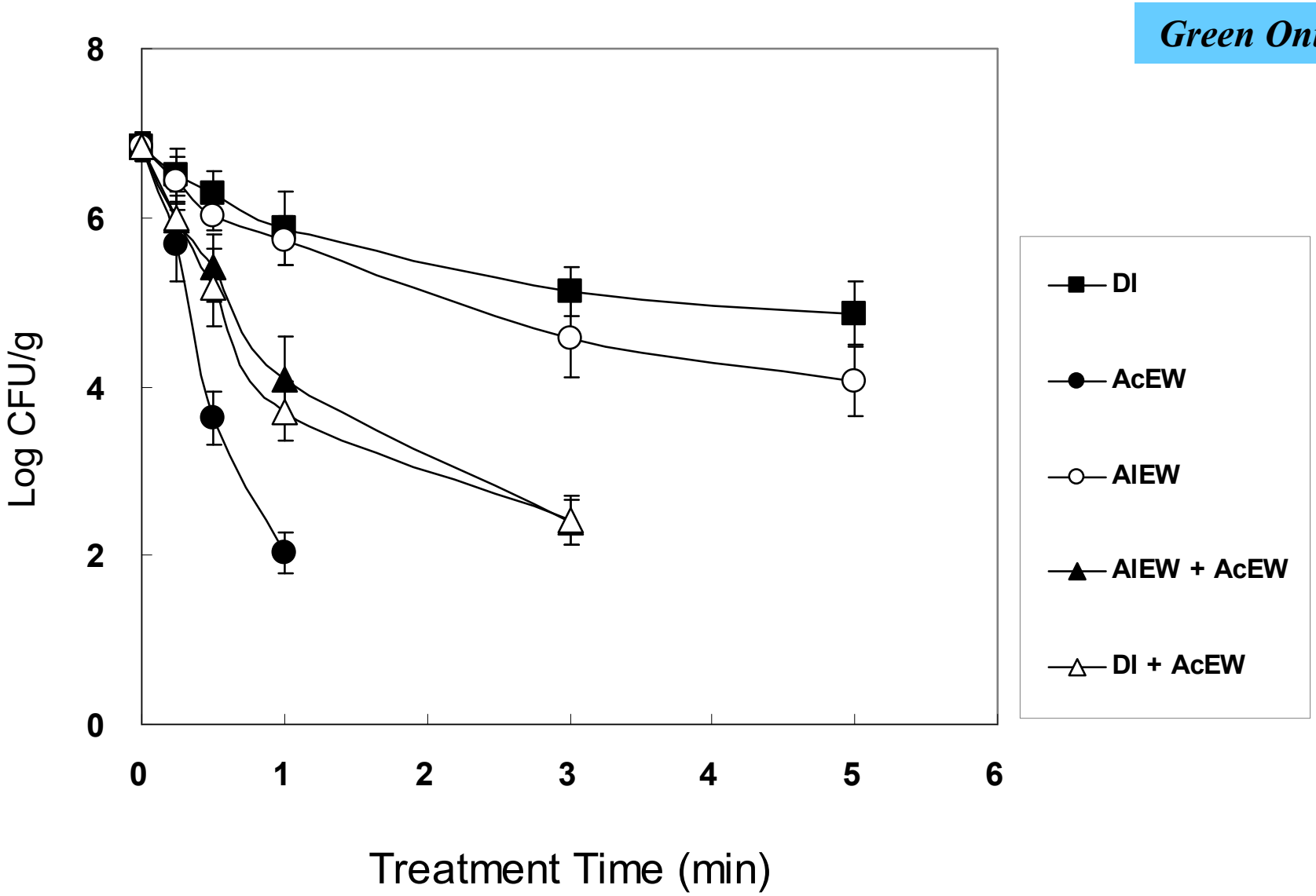


FIGURE 9.
Survival curves for ***Listeria monocytogenes*** on green onions exposed to EW

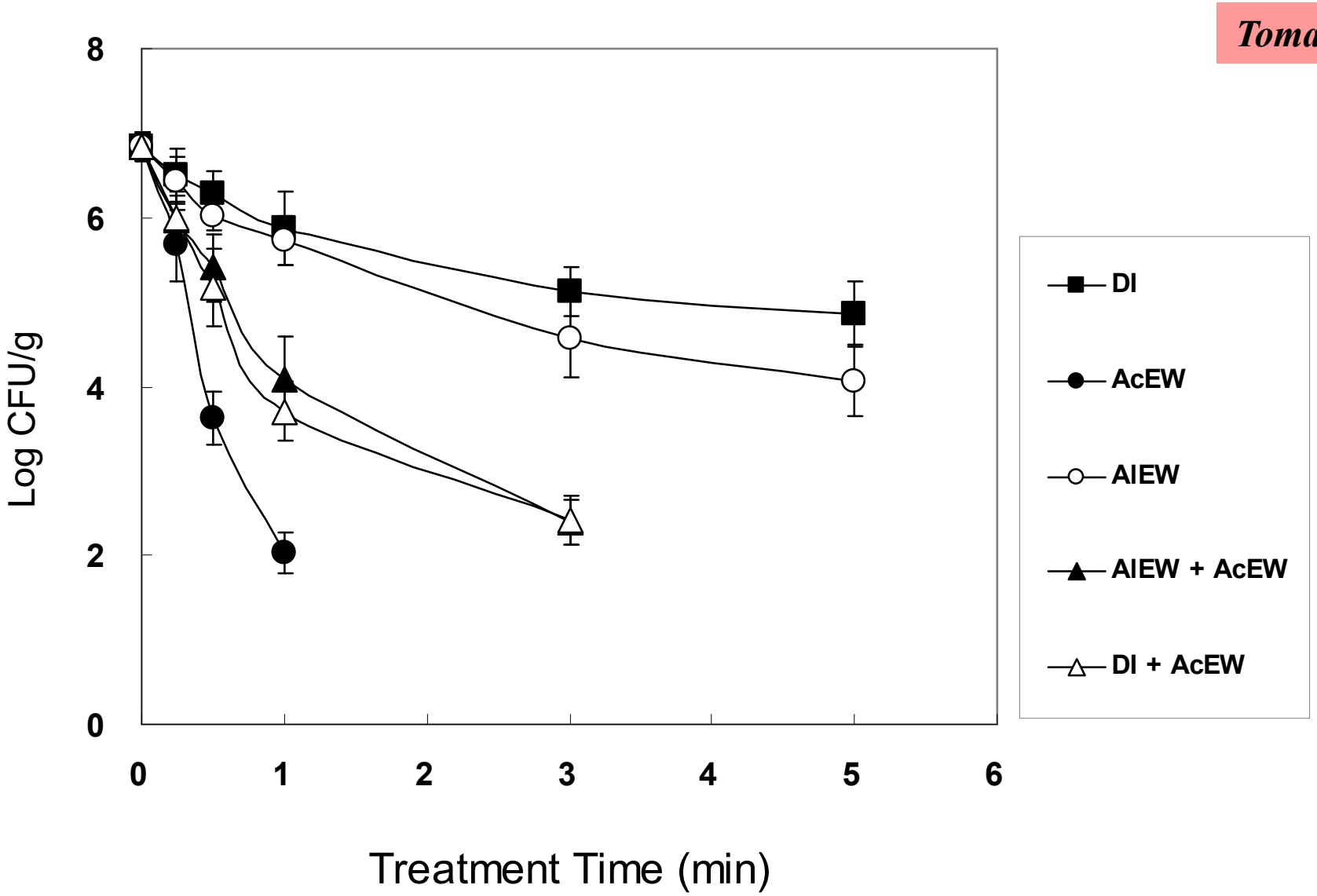


FIGURE 10.
Survival curves for ***Escherichia coli* O157:H7** on tomatoes exposed to EW

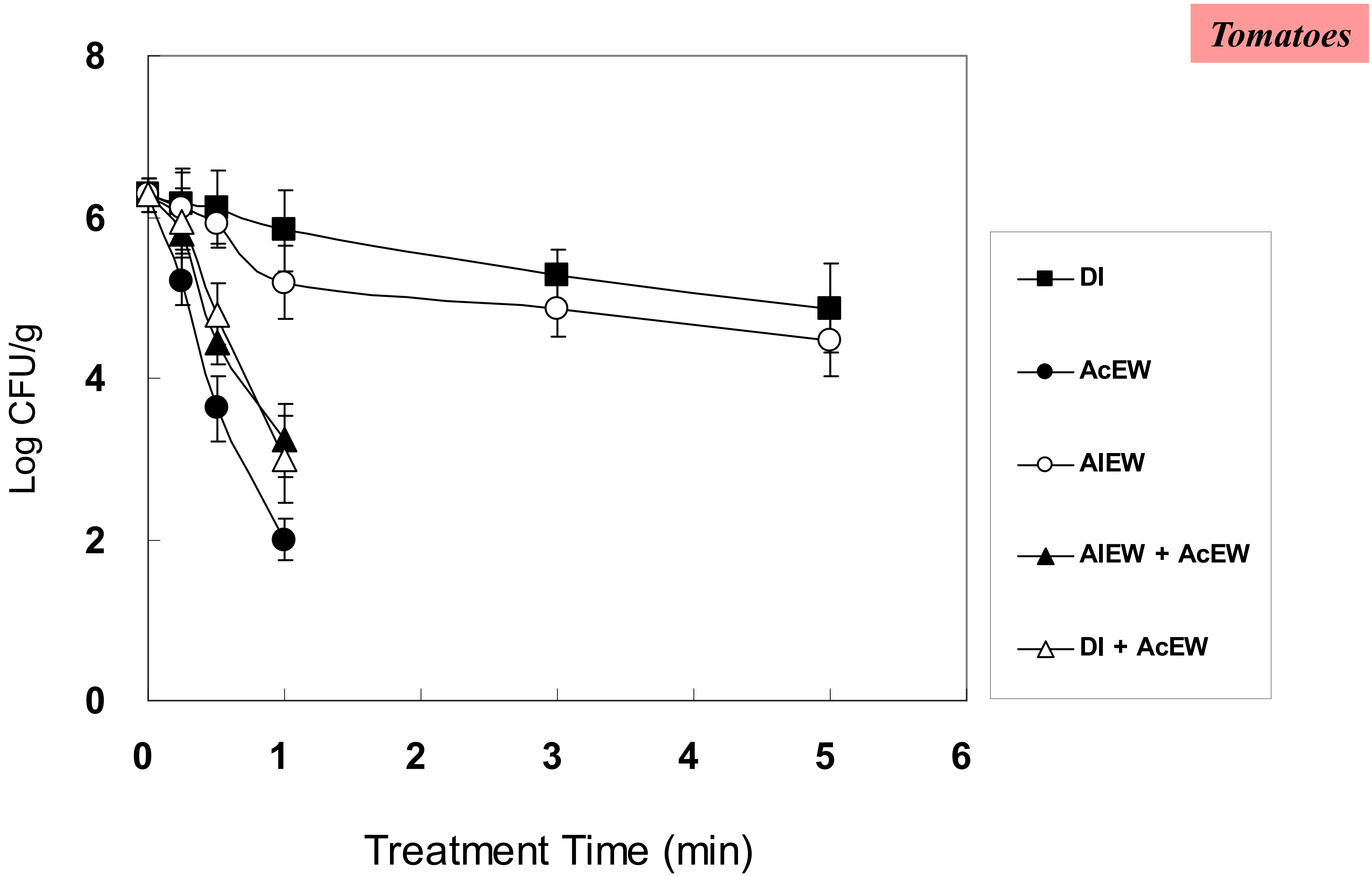


FIGURE 11.
Survival curves for ***Salmonella*** **Typhimurium** on tomatoes exposed to EW

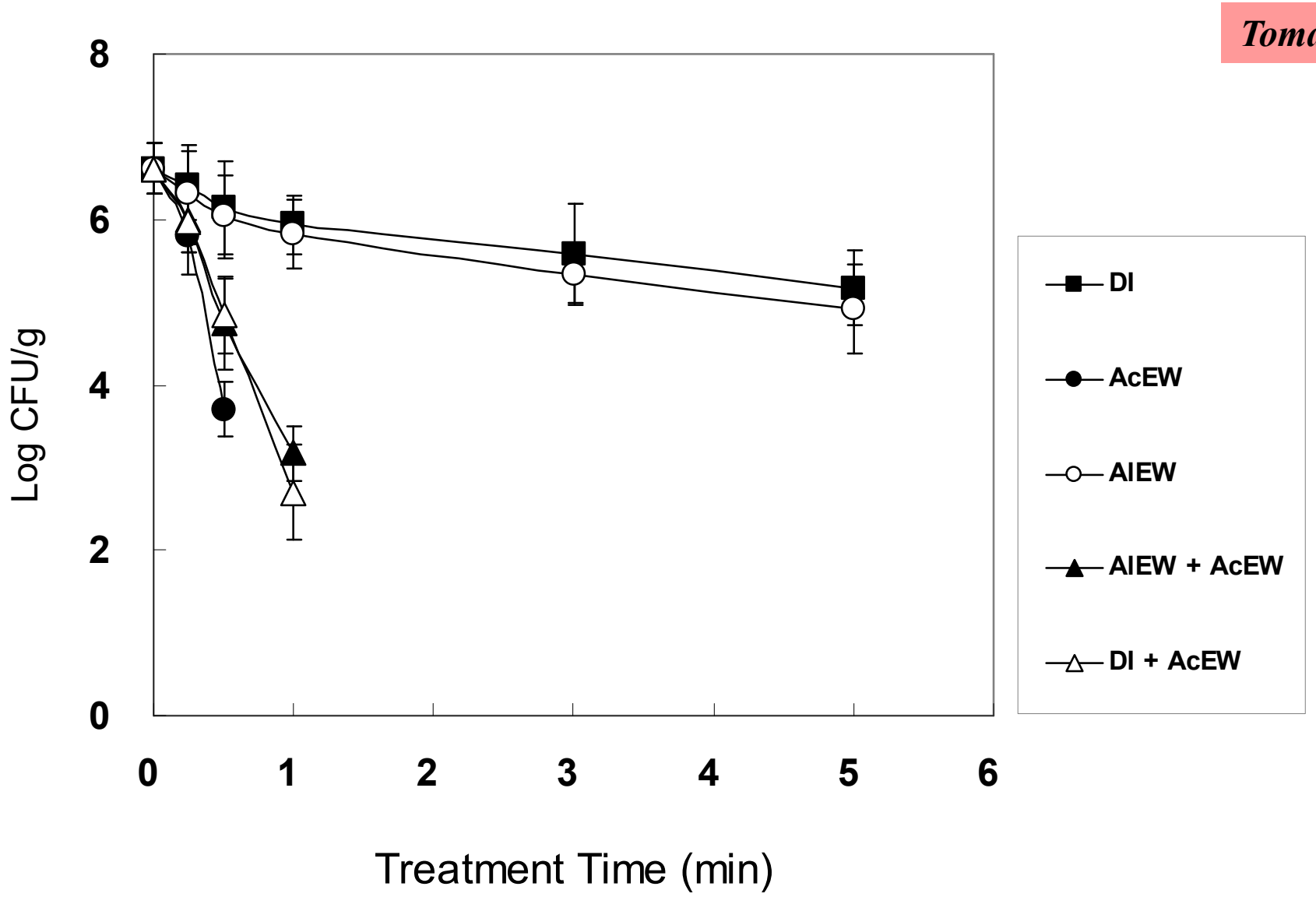


FIGURE 12.
Survival curves for ***Listeria monocytogenes*** on tomatoes exposed to EW

Effect of Electrolyzed Water for Reduction of Foodborne Pathogens On Vegetables in the Presence of Organic Matter

Introduction

1. Several factors affect the efficacy of sanitizers for food processing plant, and these may include the amount of soil present and the types of surfaces and microorganisms

2. **In practical usage**, AcEW generally has to be used in the presence of organic matters because this is an inevitable part of food-processing environments.

Materials and Methods

1. Treatment of *E. coli* O157:H7 with AcEW in the presence of organic matter

→ culture cocktails of three pathogens +

10 mL of DI and AcEW containing different concentrations (**0, 2, 4, 6, 8, 10** mL / L)

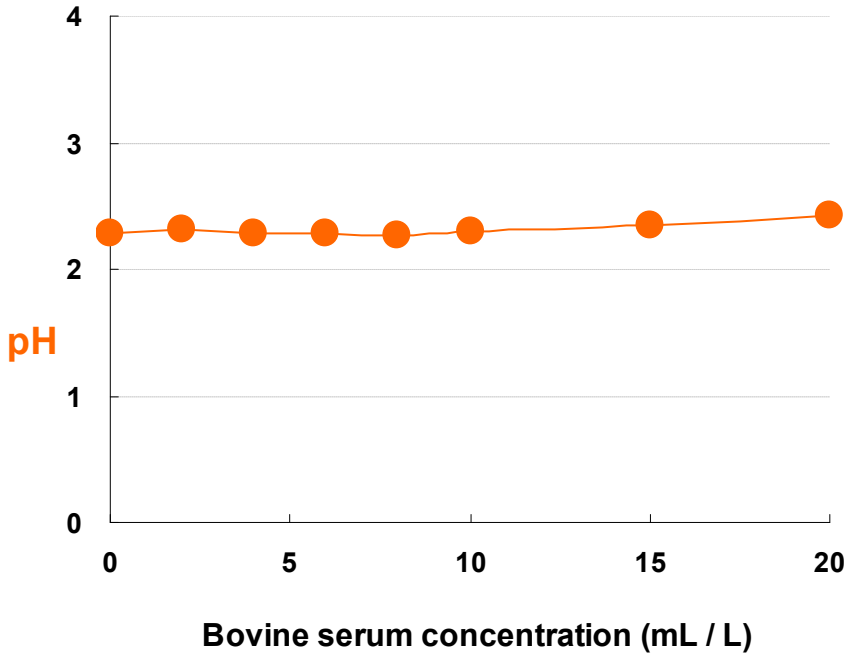
of sterile filtered **bovine serum** for **30 sec, 1 min, 3 min, and 5 min**

2. Treatment of inoculated vegetables with AcEW in the presence of organic matter

- Deionized Water (**DI**)
- Acidic Electrolyzed Water (**AcEW**)
- AcEW + **5** mL / L bovine serum
- AcEW + **10** mL / L bovine serum
- AcEW + **15** mL / L bovine serum
- AcEW + **20** mL / L bovine serum

Treatment time

- **15 sec**
- **30 sec**
- **1 min**
- **3 min**
- **5 min**



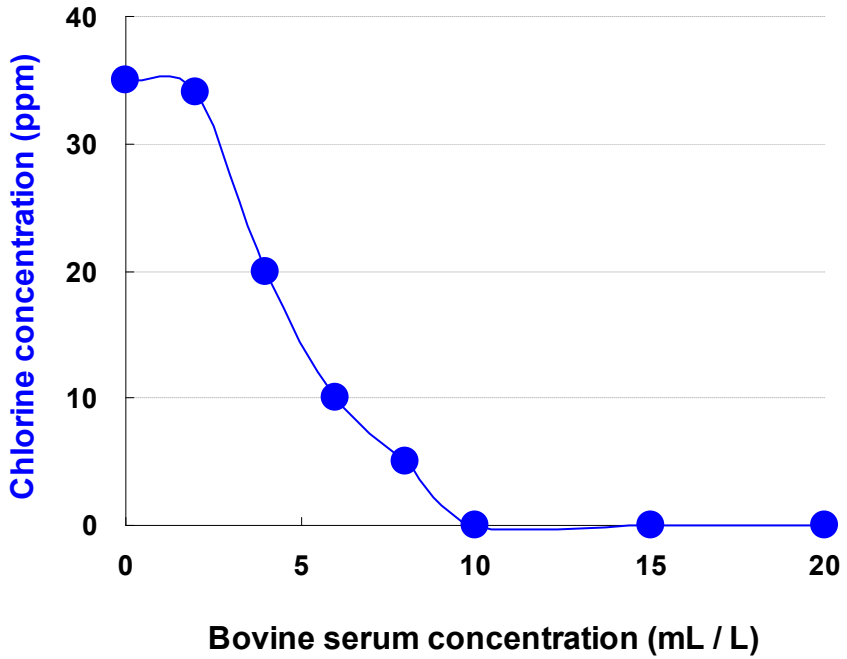


FIGURE 13.
pH and available chlorine concentration of AcEW after treating with different concentrations of bovine serum for 5 min

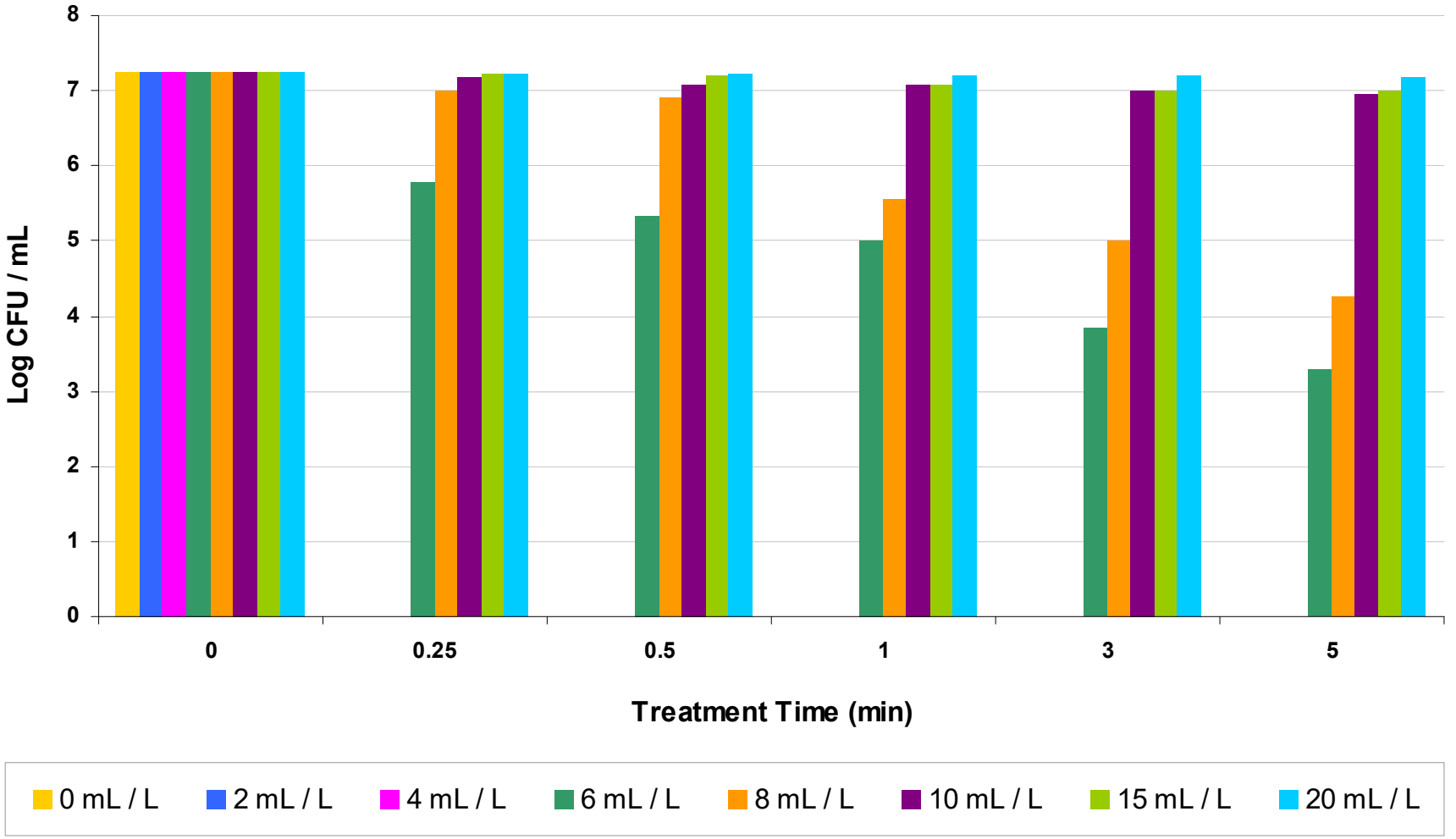


FIGURE 14.
Survival curves for ***Escherichia coli* O157:H7** treatment with AcEW in the different concentrations of bovine serum for 5 min

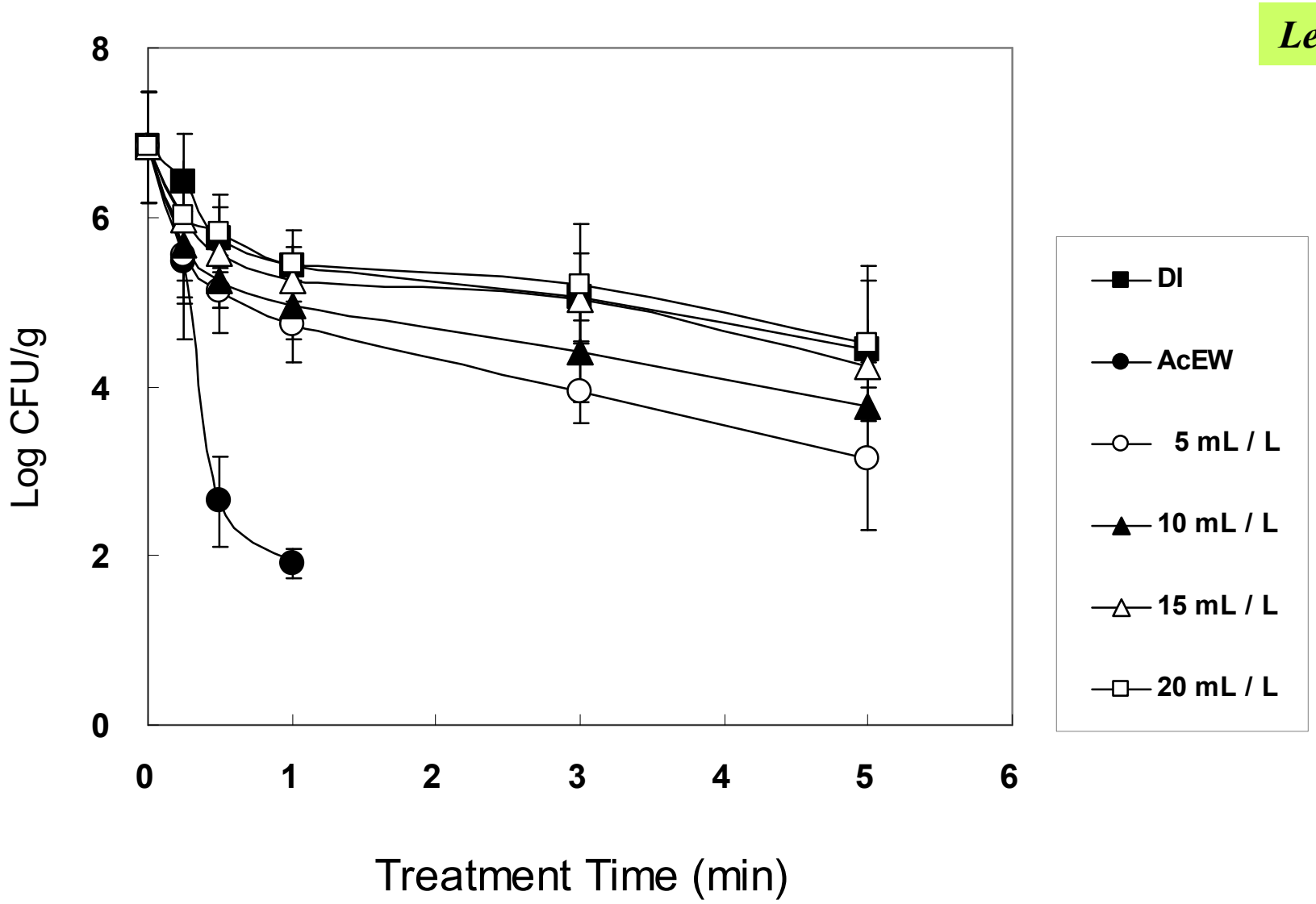


FIGURE 15.
Survival curves for ***Escherichia coli* O157:H7** on lettuce leaves exposed to ACEW with different concentrations of bovine serum

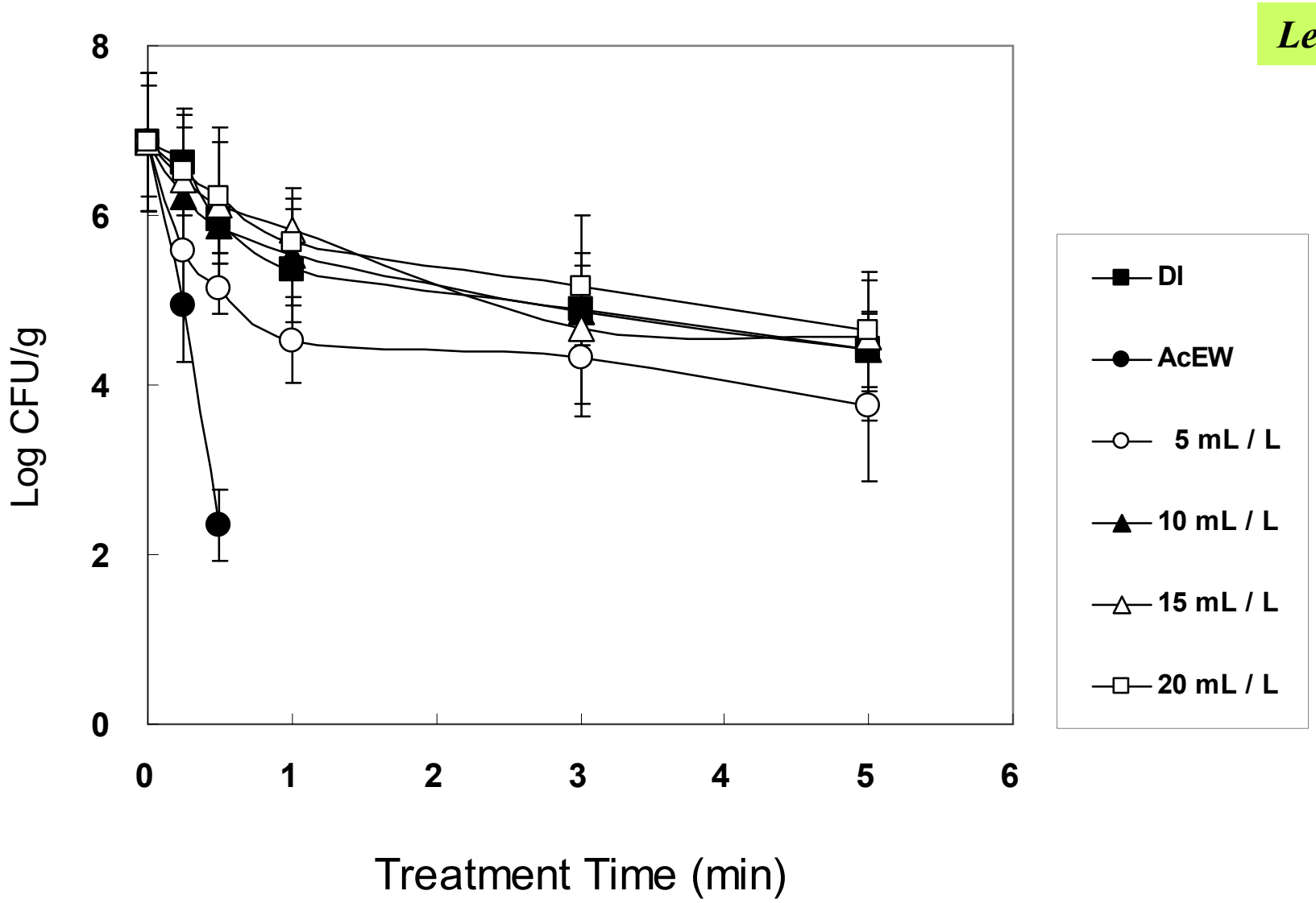


FIGURE 16.
Survival curves for ***Salmonella* Typhimurium** on lettuce leaves exposed to ACEW with different concentrations of bovine serum

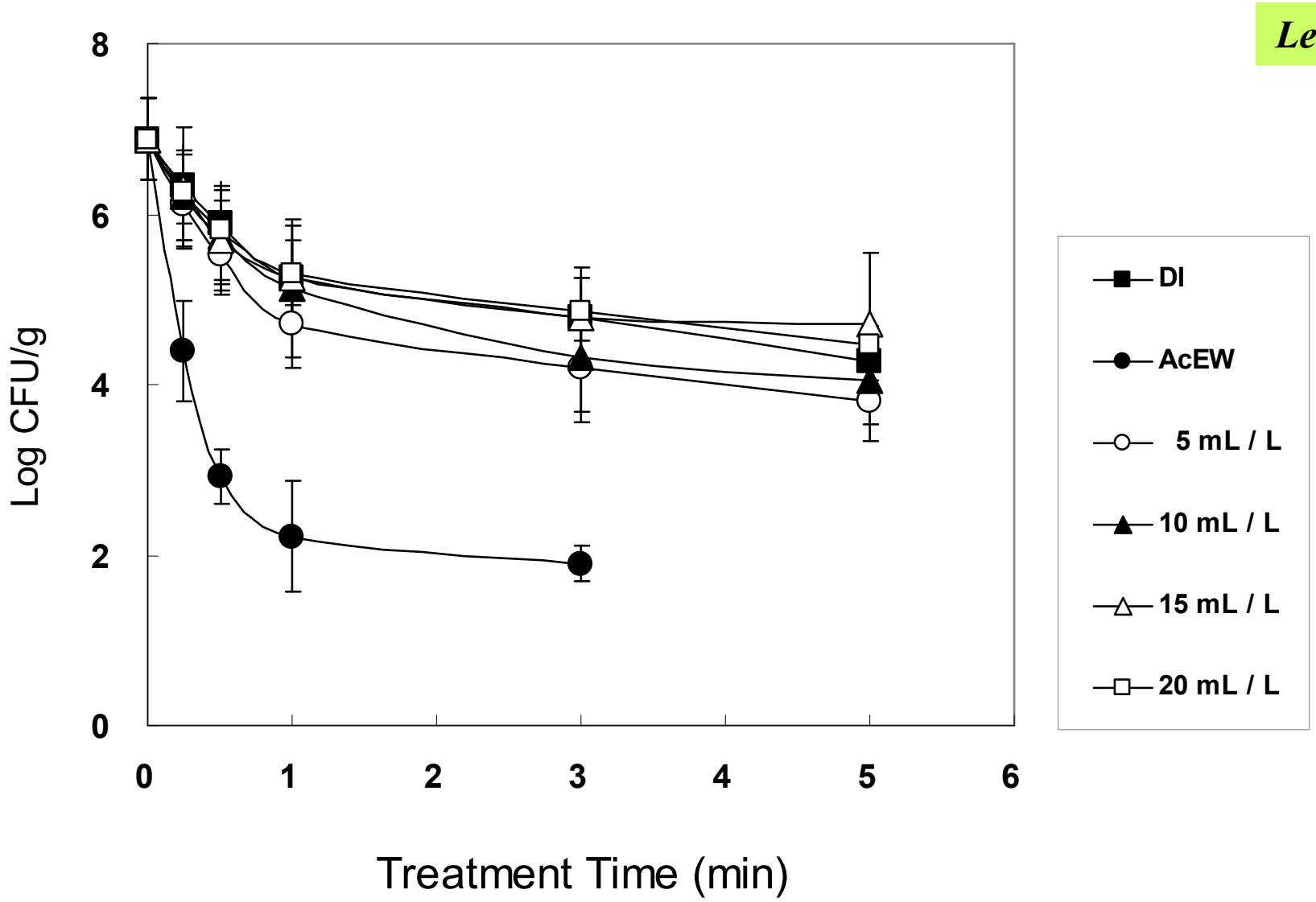


FIGURE 17.
Survival curves for ***Listeria monocytogenes*** on lettuce leaves exposed to AcEW with different concentrations of bovine serum

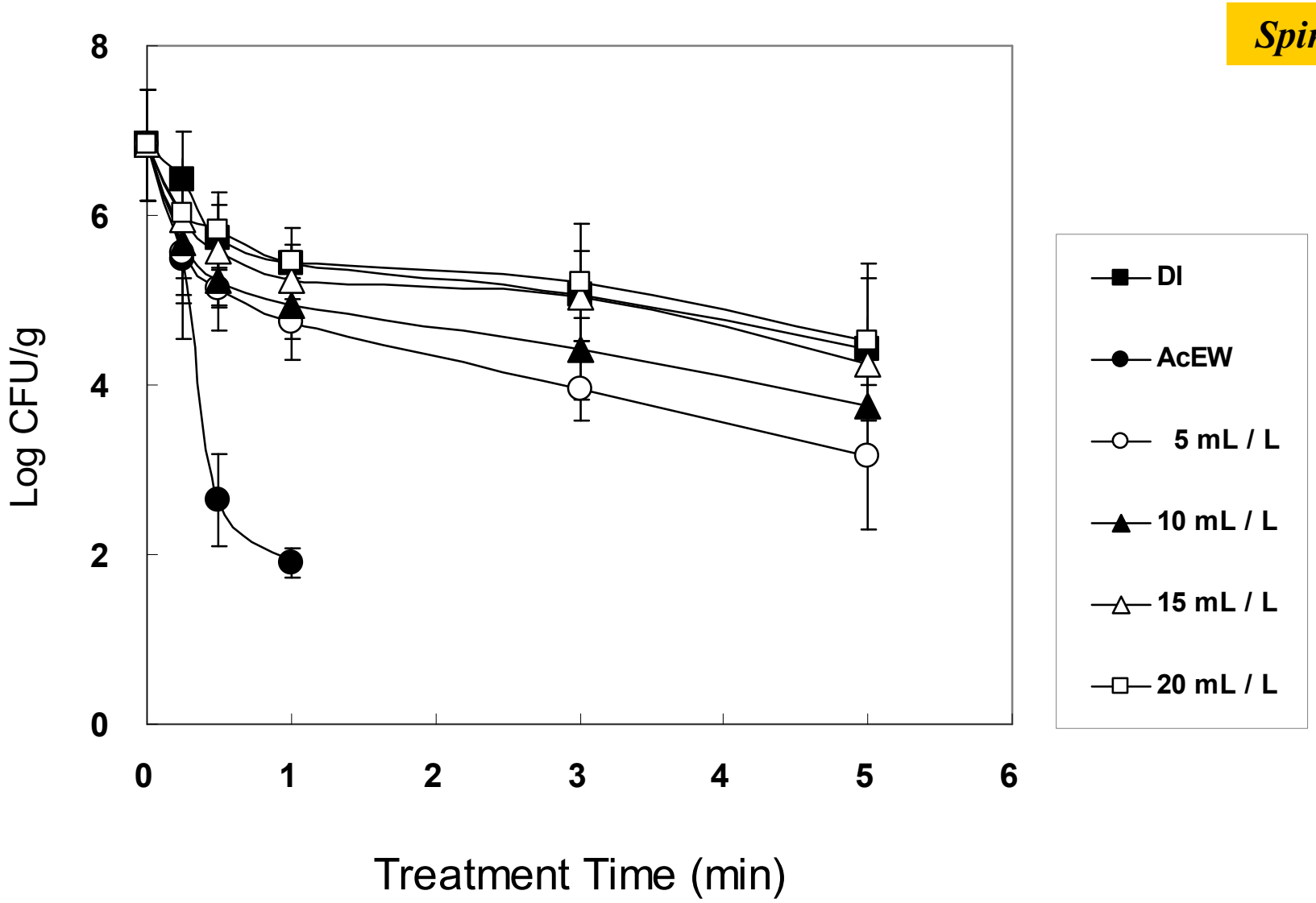


FIGURE 18.
Survival curves for ***Escherichia coli* O157:H7** on spinach leaves exposed to AcEW with different concentrations of bovine serum

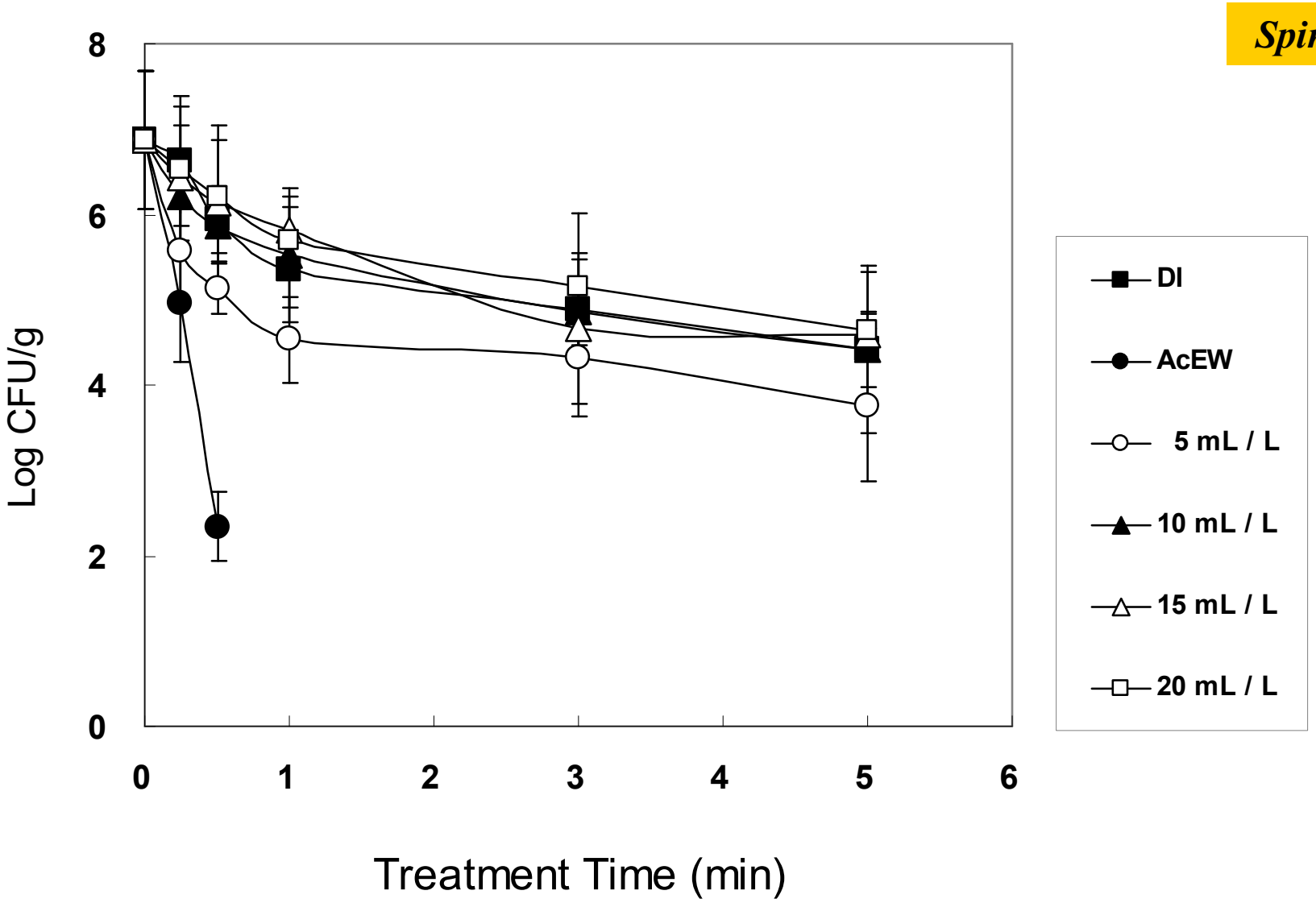


FIGURE 19.
Survival curves for ***Salmonella* Typhimurium** on spinach leaves exposed to AcEW with different concentrations of bovine serum

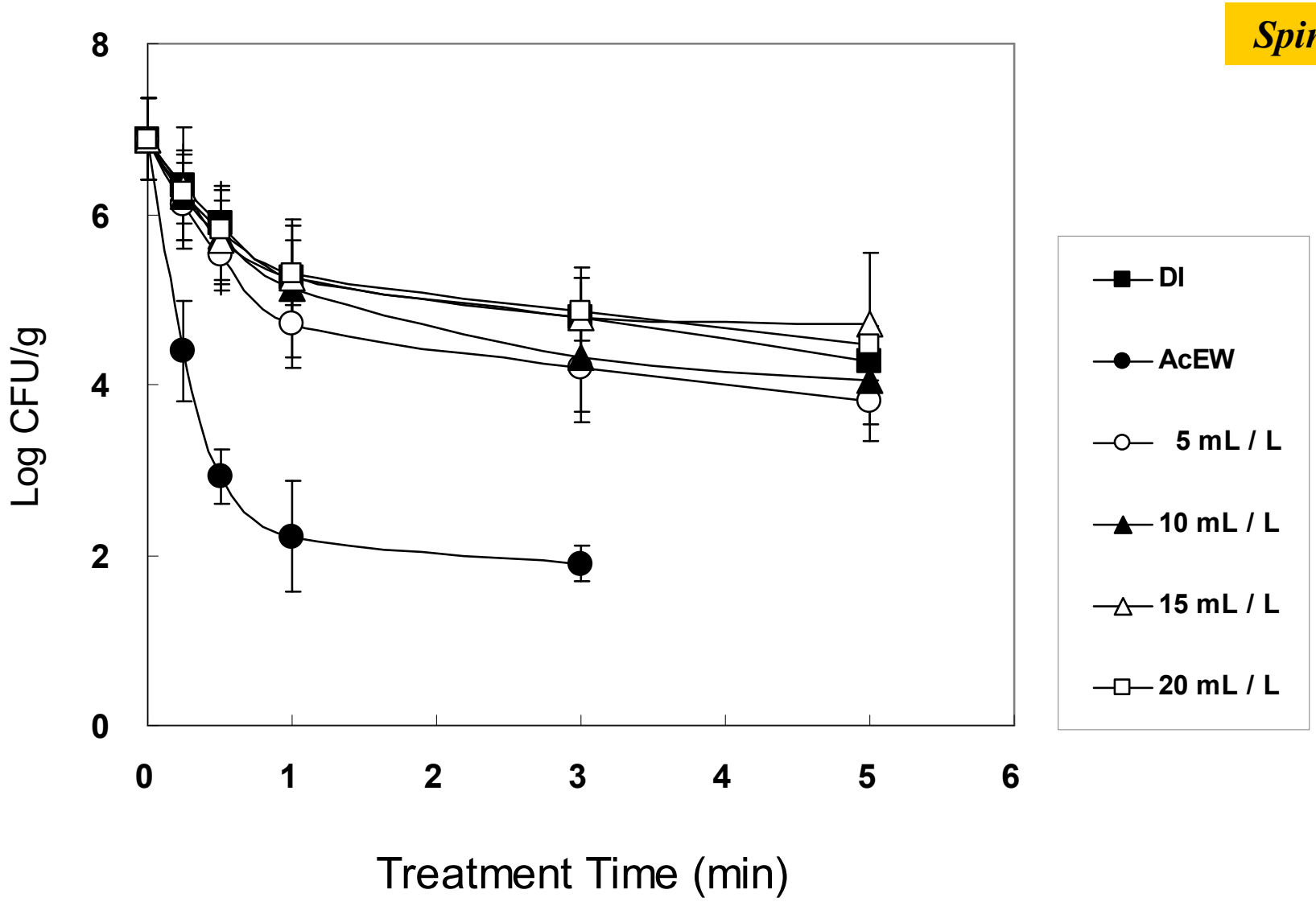


FIGURE 20.
Survival curves for ***Listeria monocytogenes*** on spinach leaves exposed to AcEW with different concentrations of bovine serum

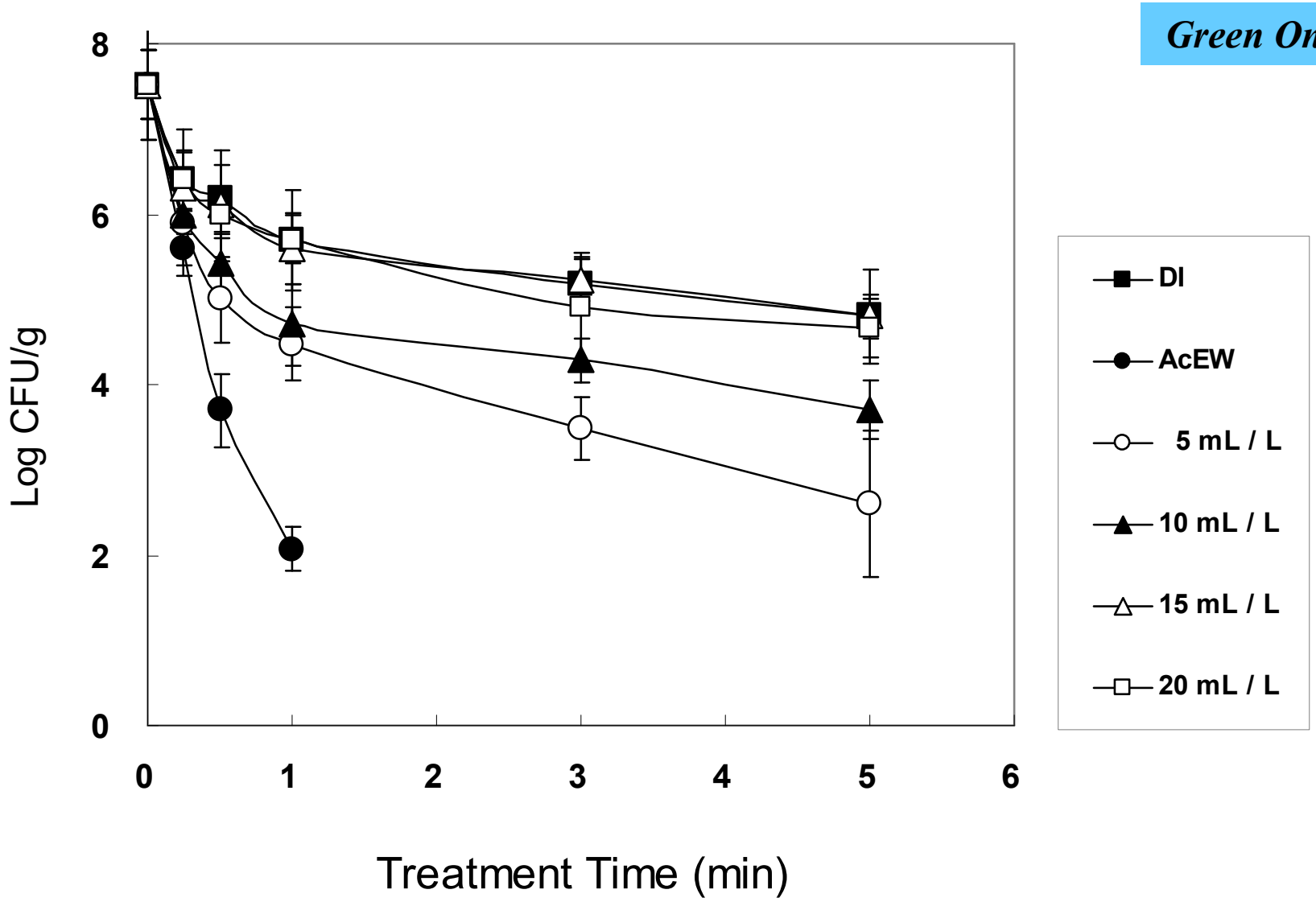


FIGURE 21.
Survival curves for ***Escherichia coli* O157:H7** on green onions exposed to AcEW with different concentrations of bovine serum

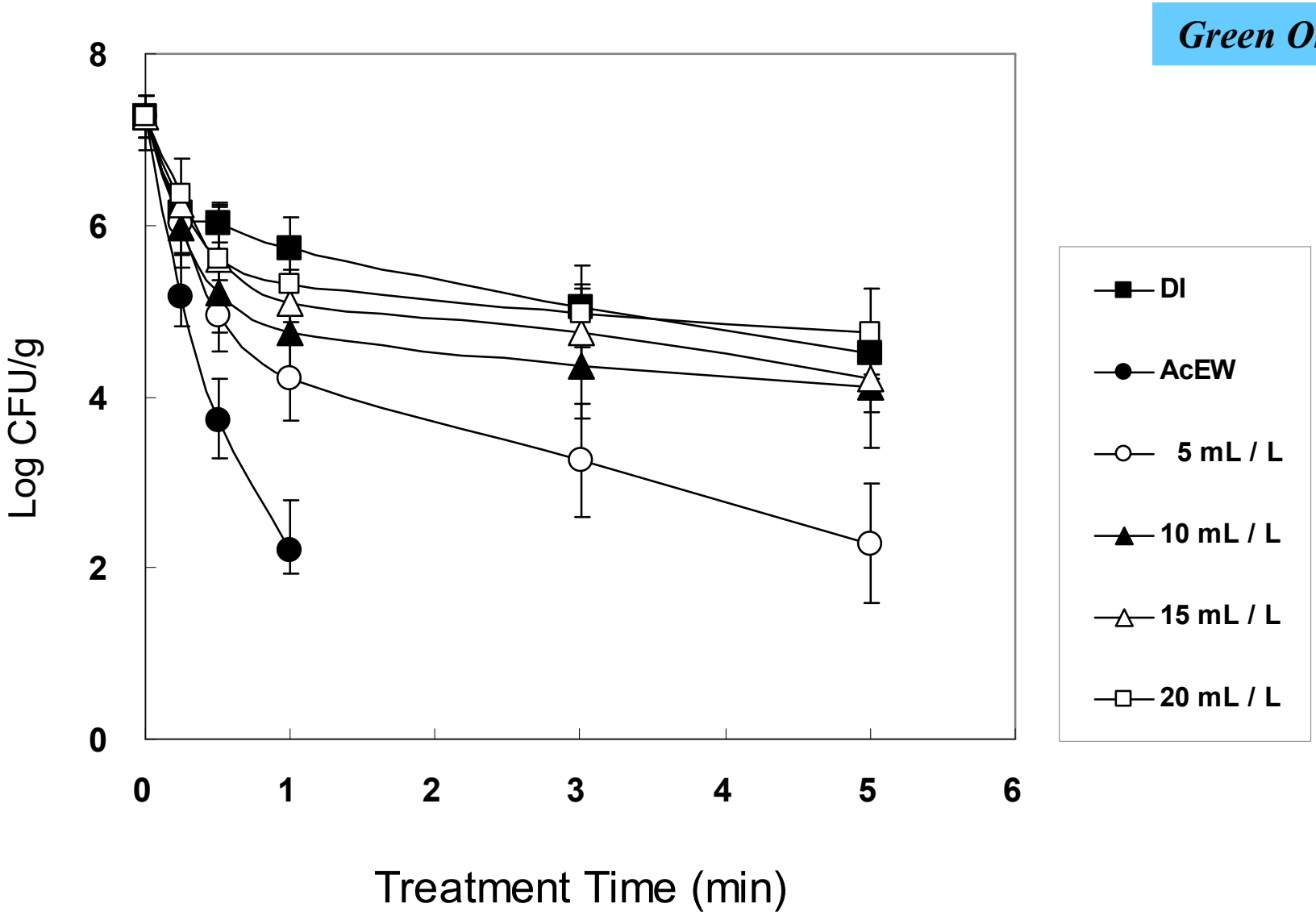


FIGURE 22.
Survival curves for ***Salmonella* Typhimurium** on green onions exposed to AcEW with different concentrations of bovine serum

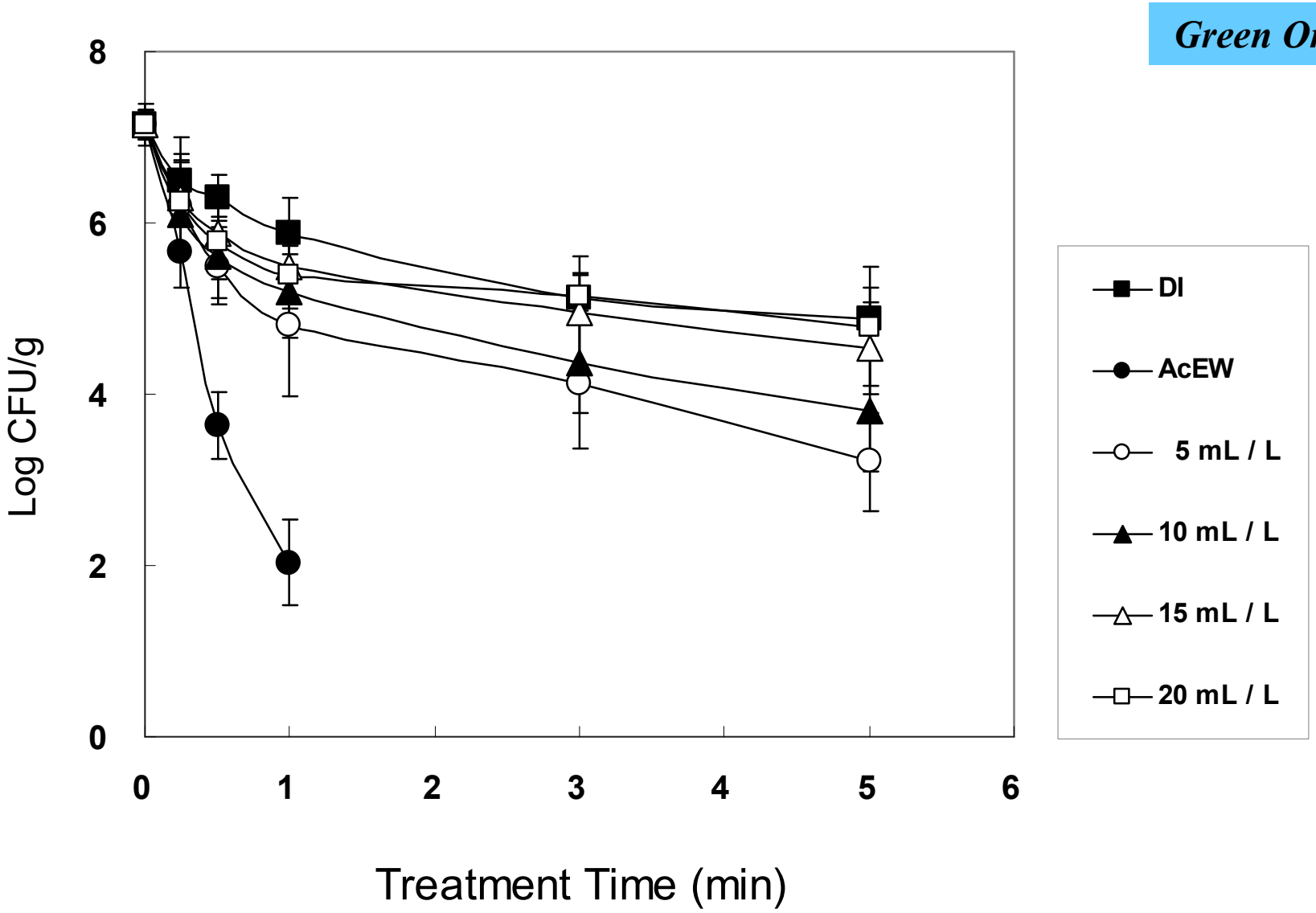


FIGURE 23.
Survival curves for ***Listeria monocytogenes*** on green onions exposed to AcEW with different concentrations of bovine serum

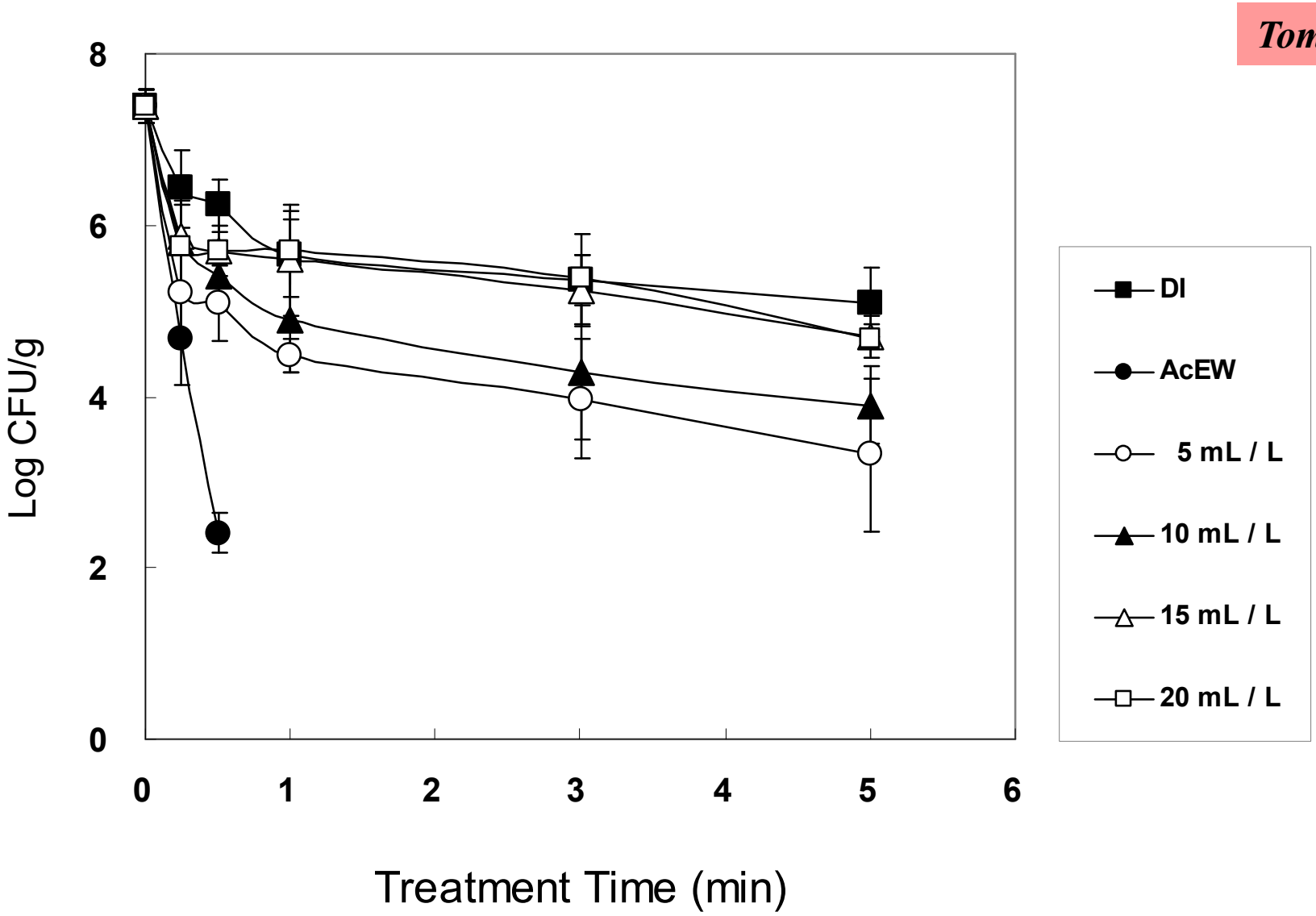


FIGURE 24.
Survival curves for ***Escherichia coli* O157:H7** on tomatoes exposed to AcEW with different concentrations of bovine serum

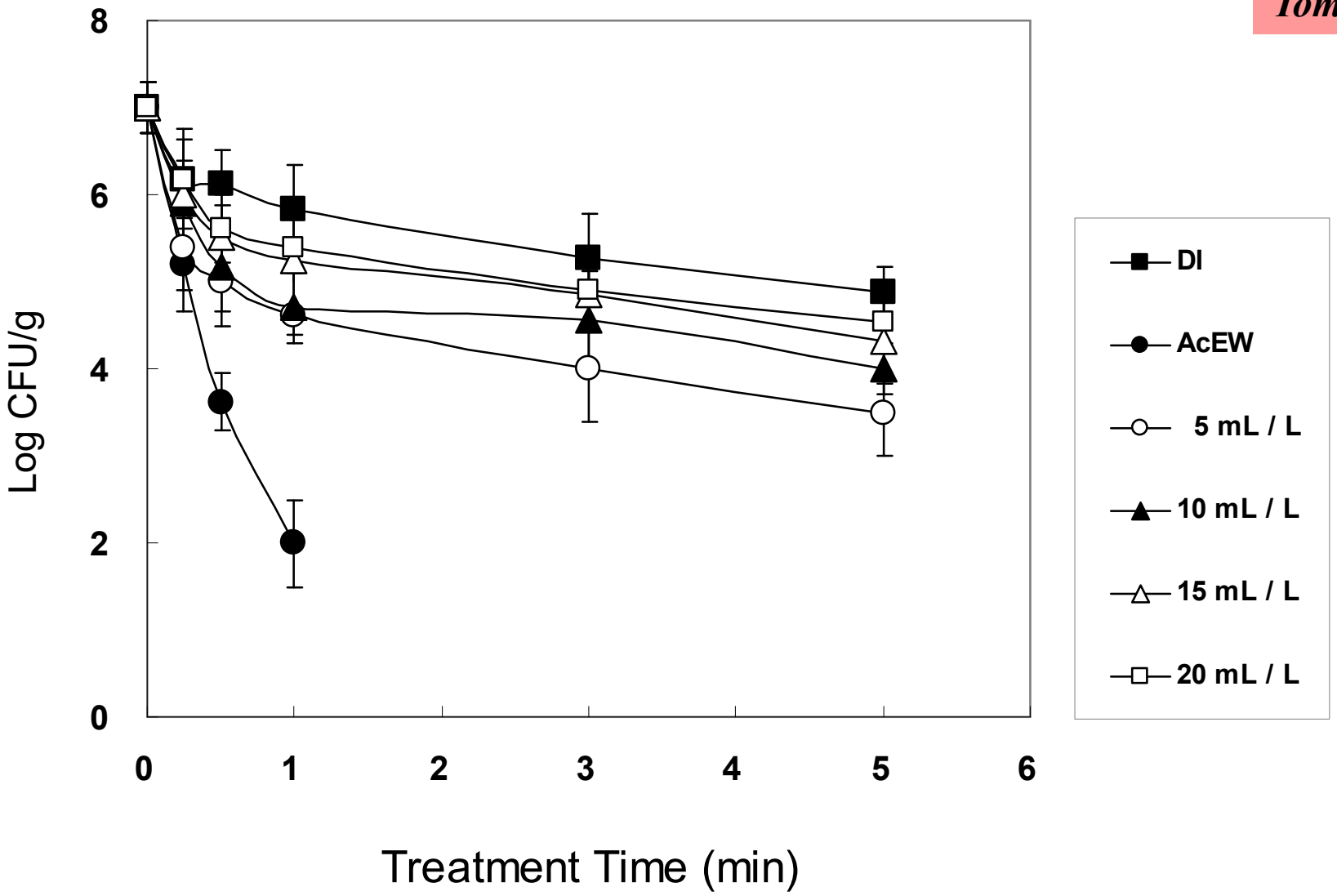


FIGURE 25.
Survival curves for ***Salmonella* Typhimurium** on tomatoes exposed to AcEW with different concentrations of bovine serum

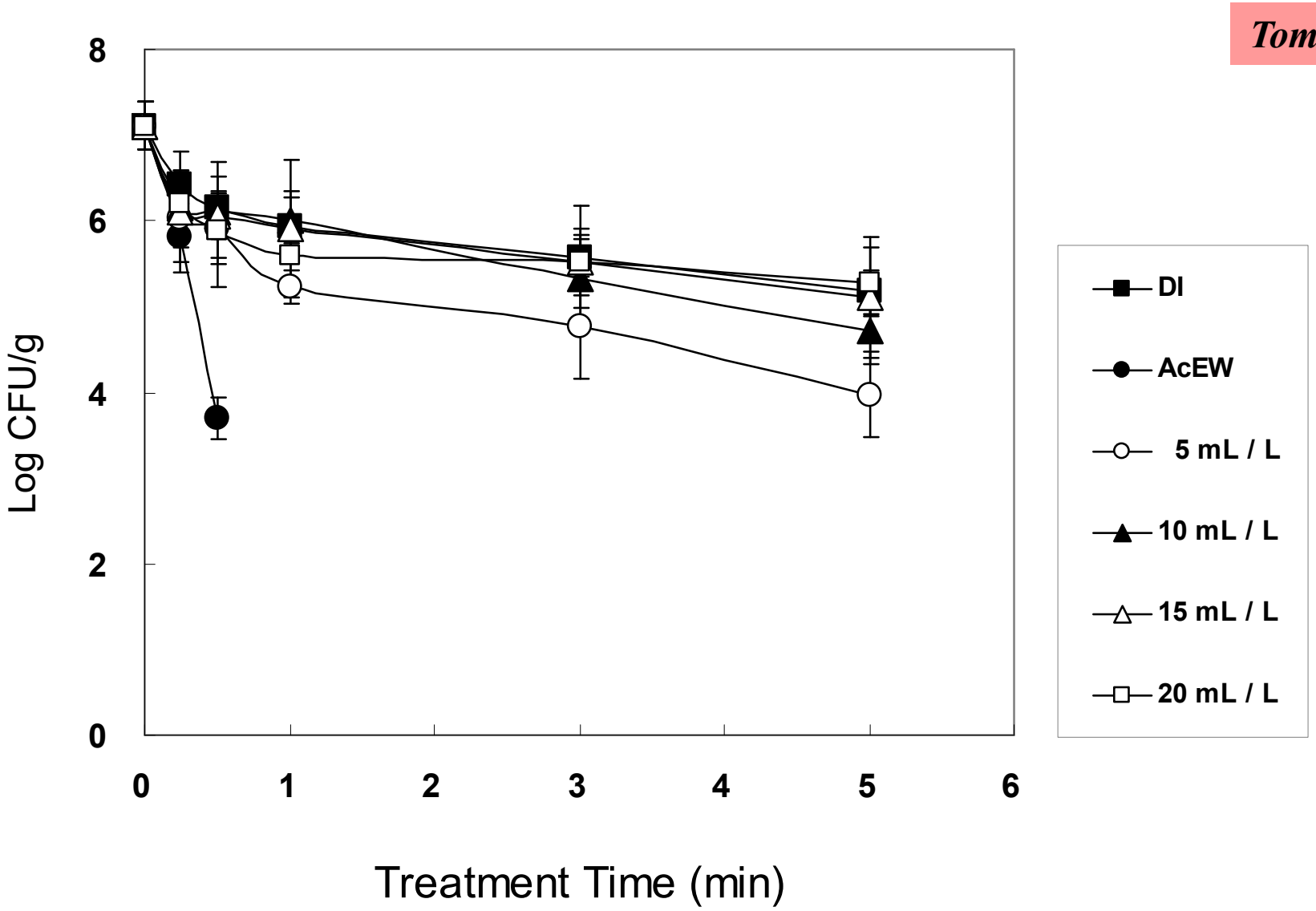


FIGURE 26.
Survival curves for ***Listeria monocytogenes*** on tomatoes exposed to AcEW with different concentrations of bovine serum