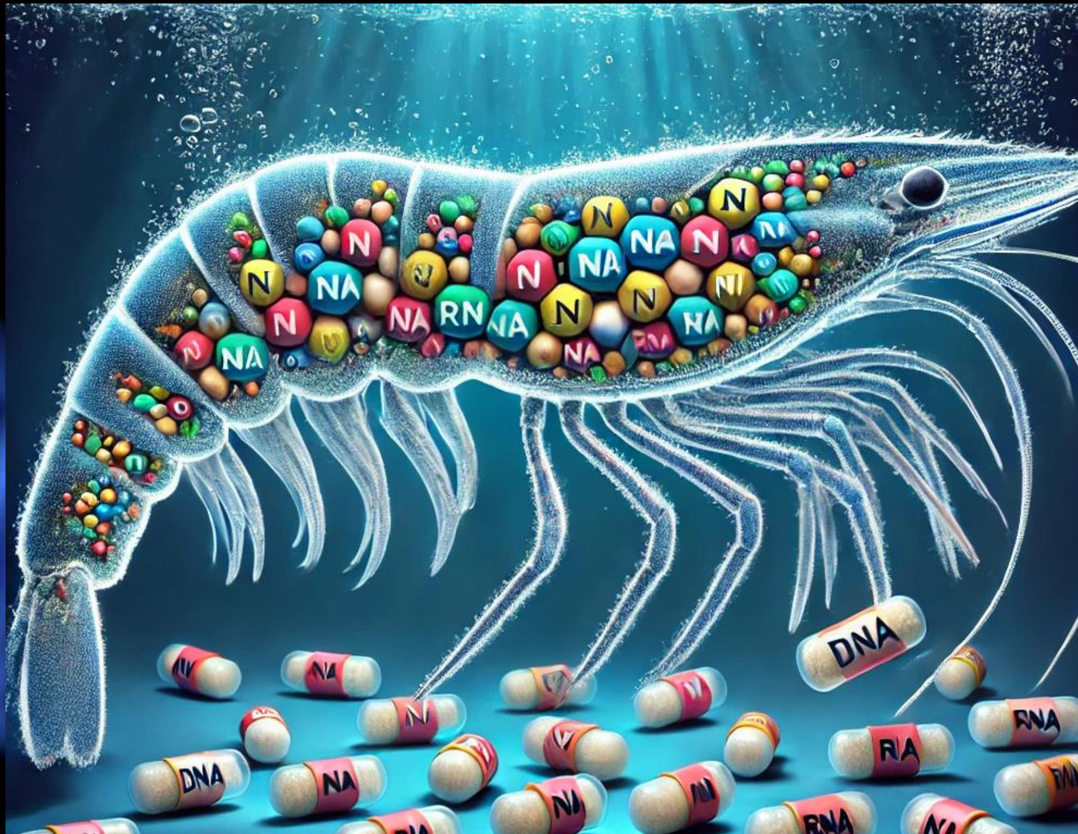
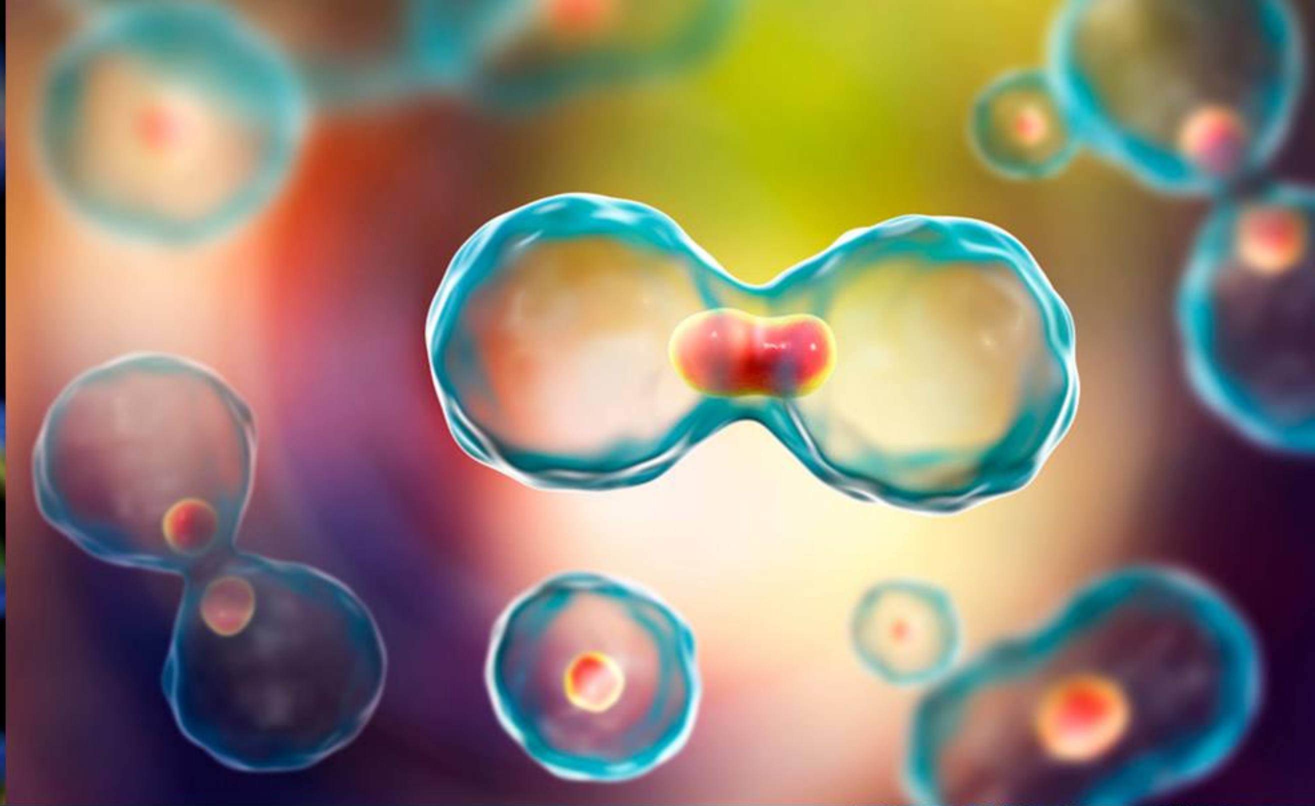
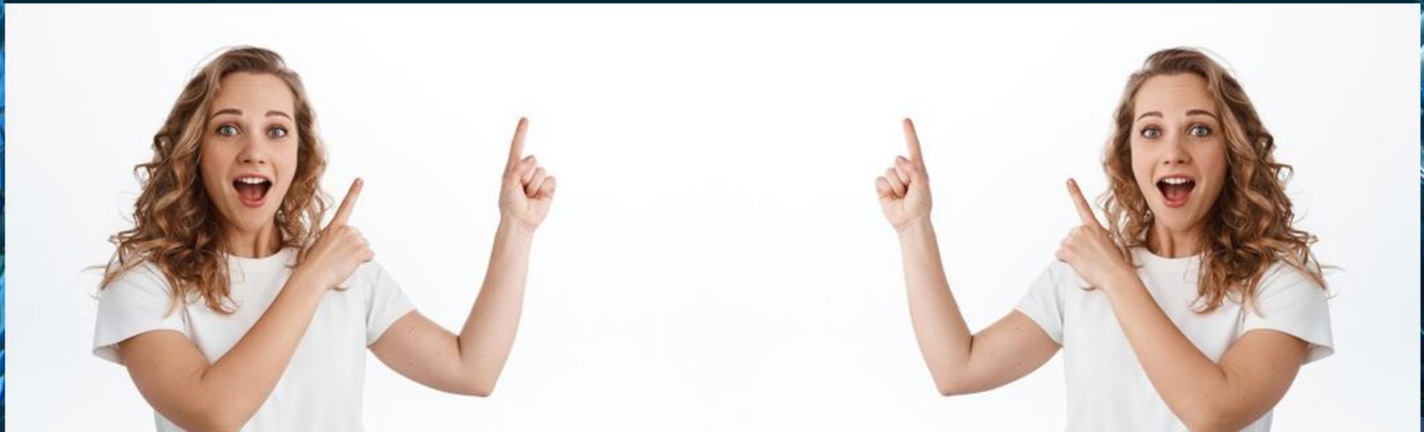
SUSTAINABLE FEEDS
for
Sustainable Aqua Farming

Marcelo Borba





Each New Cell Requires 1 Billion Nucleotides to Duplicate



Effects of dietary yeast-derived nucleotide and RNA on growth performance, survival, immune responses, and resistance to *Vibrio parahaemolyticus* EMS/AHPND infection in Pacific white shrimp (*Litopenaeus vannamei*)


Aquaculture Reports 27 (2022) 101352

Contents lists available at ScienceDirect

Aquaculture Reports

journal homepage: www.elsevier.com/locate/aqrep

Effects of dietary yeast-derived nucleotide and RNA on growth performance, survival, immune responses, and resistance to *Vibrio parahaemolyticus* infection in Pacific white shrimp (*Litopenaeus vannamei*)

Tirawat Rairat[a], Niti Chuchird[a,*], Arunothai Keetanon[a], Paolo Carcano[b], Marcello Comi[c], Wolfgang Koppe[d]

[a] Department of Fishery Biology, Faculty of Fisheries, Kasetsart University, Bangkok 10900, Thailand
[b] Prosol S.p.A., Via Carso, 99, 24040 Madone, BG, Italy
[c] Department of Human Science and Quality of Life Promotion, Università Telematica San Raffaele, Via di Val Cannuta 247, 00166 Rome, Italy
[d] Simplyfish AS, Bakkegata 12, 4011 Stavanger, Norway

ARTICLE INFO

Keywords:
Bacterial diseases
Feed additive
Kluyveromyces fragilis
Nucleotide
Ribonucleic acid

ABSTRACT

Nucleotides (NT) and RNA from yeast extracts are gaining interest as high-value feed additives. The present study intended to evaluate the influences of yeast derived-NT and RNA on the growth performance, survival, immune responses, and resistance to *Vibrio parahaemolyticus* infection in Pacific white shrimp. In Experiment 1, postlarvae were distributed into 7 groups, corresponding to 7 experimental diets: control, NT 0.25, NT 0.50, NT 0.75, RNA 0.25, RNA 0.50, and RNA 0.75 g/kg feed. They were fed the experimental diets for 45 days. Then, their body weights, survival rates, immune parameters, and *Vibrio* spp. counts in the hepatopancreas and intestines were determined. In Experiment 2, the shrimp from Experiment 1 were challenged by immersion with *V. parahaemolyticus* at 10^5 CFU/mL. Each group was fed the same diet for another 10 days to assess the disease resistance performance. The results revealed that the shrimp body weights of all groups were similar suggesting that neither NT nor RNA exerts the growth-promoting effect. However, the average survival rates of the NT and RNA groups were in the range of 89–93 %, significantly higher than that of the control (83 %). These increased survivals were in line with the reduction in the hepatopancreatic and intestinal *Vibrio* spp. counts and the elevated immune parameters in the NT and RNA-fed shrimp. At day 10 after the bacterial challenge, the highest survival rates were observed in the RNA 0.50 and 0.75 g/kg feed groups (81 % and 82 %, respectively), followed by the RNA 0.25 (70 %) and NT 0.75 g/kg feed (68 %), and significantly higher than the positive control (54 %). In short, both yeast-derived NT and RNA, especially the RNA at the dose of 0.50–0.75 g/kg feed groups, showed promising health benefits effects in the Pacific white shrimp, notably the improved immune function and disease resistance.

1. Introduction

Nucleotides (NT) are basic units of nucleic acids (RNA and DNA) and play a key role in several biochemical processes. NT consists of nitrogenous bases (i.e., purines and pyrimidines), pentose sugar (i.e., ribose and deoxyribose), and phosphate group(s). However, NT are traditionally not considered to be an essential nutrient because they can be produced endogenously under normal conditions via a salvage pathway in which the NT is synthesized from the nitrogenous bases and nucleosides formed during RNA and DNA degradation and *de novo* synthesis from amino acids and other molecules (Carver and Walker, 1995; Grimble and Westwood, 2001; Li and Gatlin, 2006). However, the production of NT may be insufficient to fulfill its demand in certain conditions such as infection, stress, or during rapid growth (Hess and Greenberg, 2012; Hossain et al., 2020). Thus, supplementation of exogenous NT can potentially be useful in these circumstances. The beneficial effects of dietary NT on human health regarding gastrointestinal growth and development, hepatic function, and immune system are documented (Carver and Walker, 1995; Hess and Greenberg, 2012). In addition, the advantages of using dietary NT in fish and shrimp

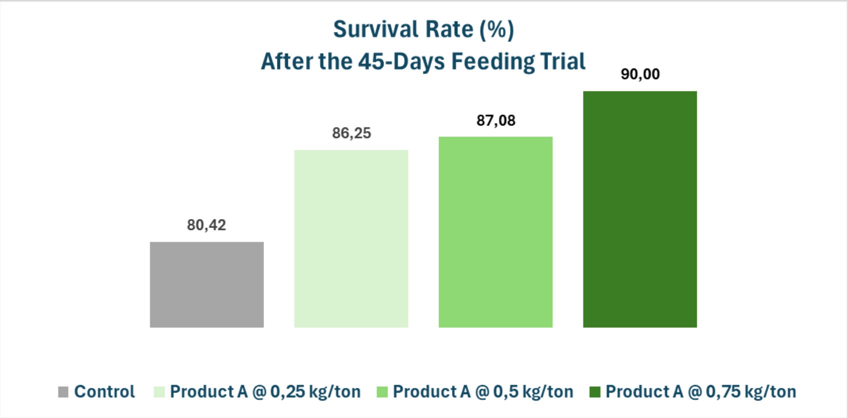
* Corresponding author.
E-mail address: ffisntc@ku.ac.th (N. Chuchird).

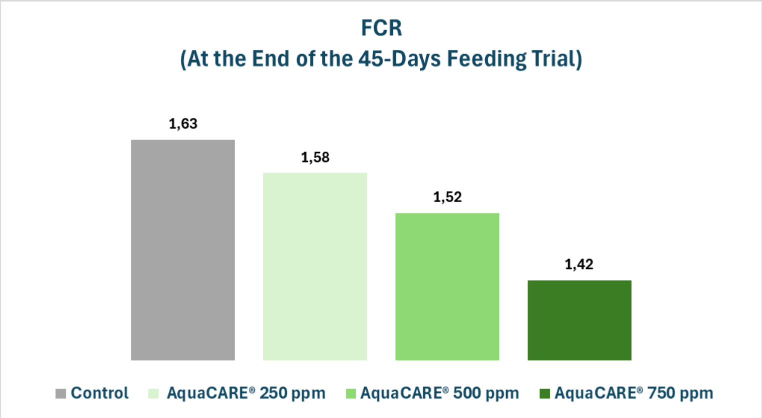
https://doi.org/10.1016/j.aqrep.2022.101352
Received 19 June 2022; Received in revised form 27 September 2022; Accepted 28 September 2022
Available online 4 October 2022

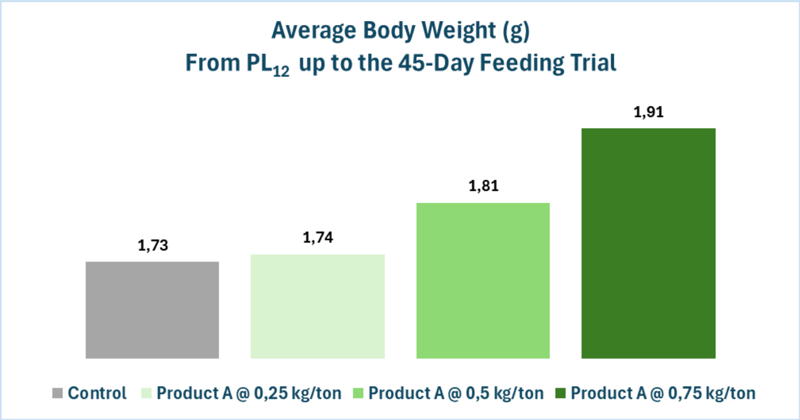
Scientific Trial 01: Kasetsart University, Thailand

Published by Elsevier B.V.
Aquaculture Reports 27 (2022) 101352

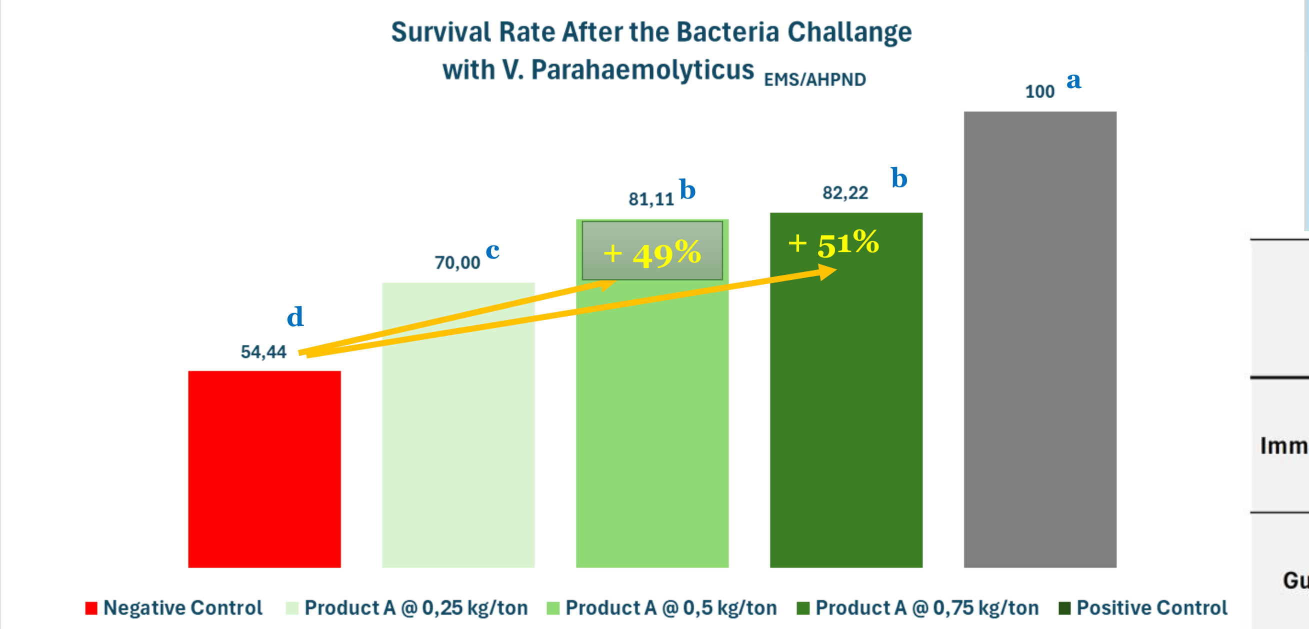
Zootechnical KPIs (PL_{12} up to Young Juveniles) Before Bacterial Challange

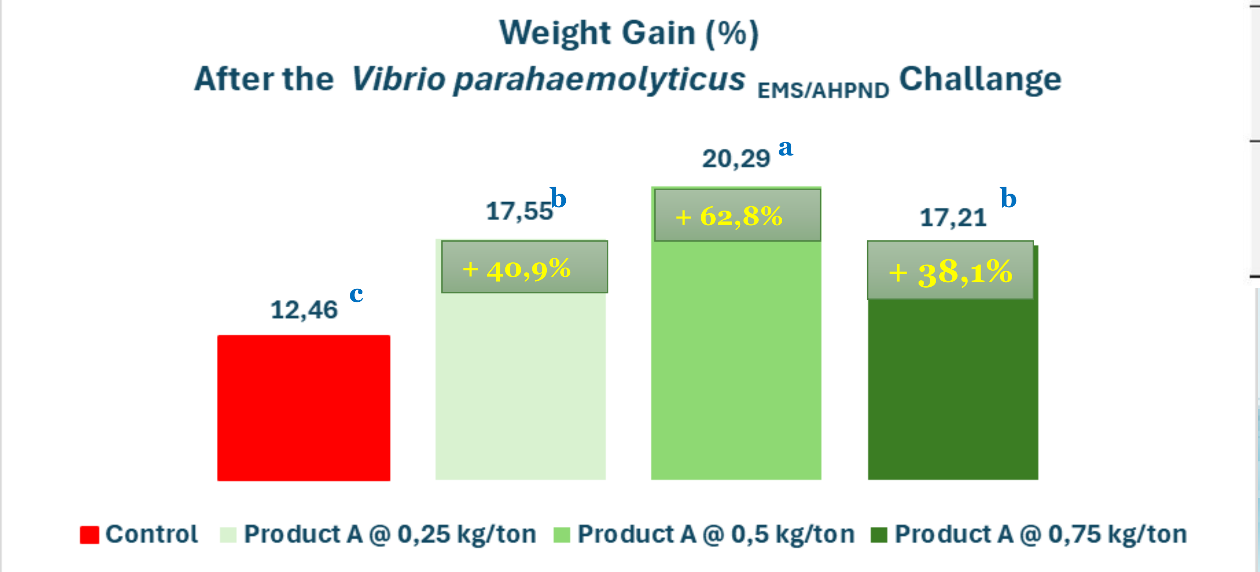






Zootechnical KPI
After Bacterial Challange



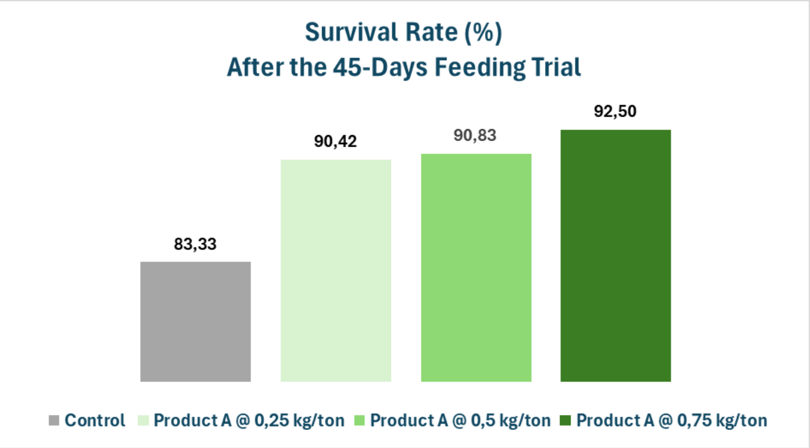


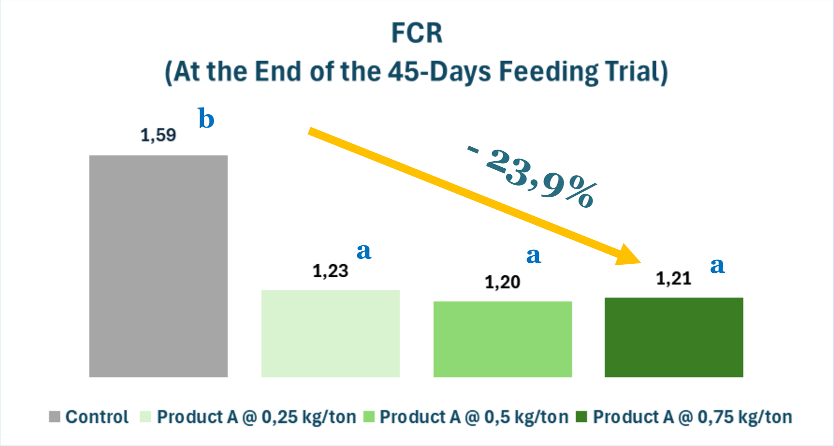
Overall Trials' Stats

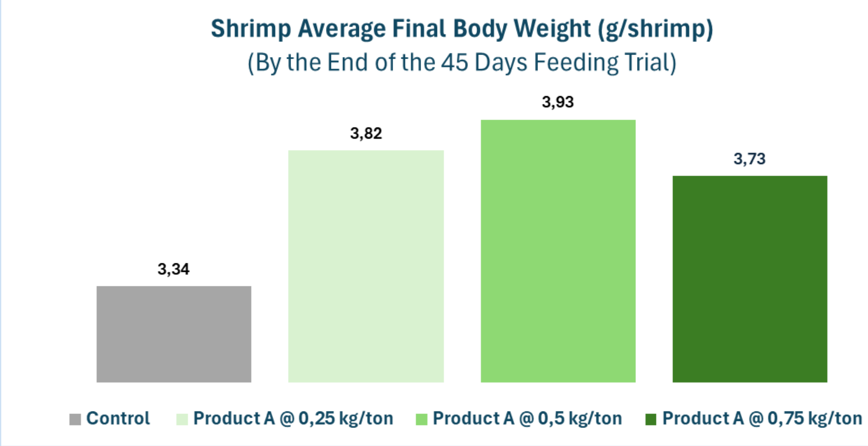
Key Parameters		Numerical and Statistical Differences Across Treatments							
		Control		AquaCARE (0,25 kg/ton)		AquaCARE (0,5 kg/ton)		AquaCARE (0,75 kg/ton)	
Immunological	Total Hemocyte Count - THC (10^6 cell/mL)	1,95	c	3,23	b	3,94	a	4,09	a
	Phagocytic Activity (%)	51,67	c	61,00	b	64,67	a	65,67	a
Gut Health	Total Vibrio spp. count Hepatopancreas (10^3 CFU / g)	9,60	c	6,77	b	3,67	a	4,10	a
	Vibrio spp. count Intestines (10^2 CFU / g)	10,27	c	3,53	b	1,47	a	1,70	a
Anti-Oxidant Enzymes	Superoxide Dismutase - SOD (% inhibition)	33,33	c	40,28	b	42,71	a	44,79	a
	Phenoloxidase - PO (units/min/mg protein)	220,32	c	243,41	b	255,36	a	256,06	a
Zootechnical	Weight Gain (%) after Bacterial Challange Vibrio parahaemolyticus (AHPND)	12,26	c	17,55	b	20,29	a	17,21	b
	Survival after Bacterial Challange Vibrio parahaemolyticus (AHPND)	54,44	c	70,00	b	81,11	a	82,22	a

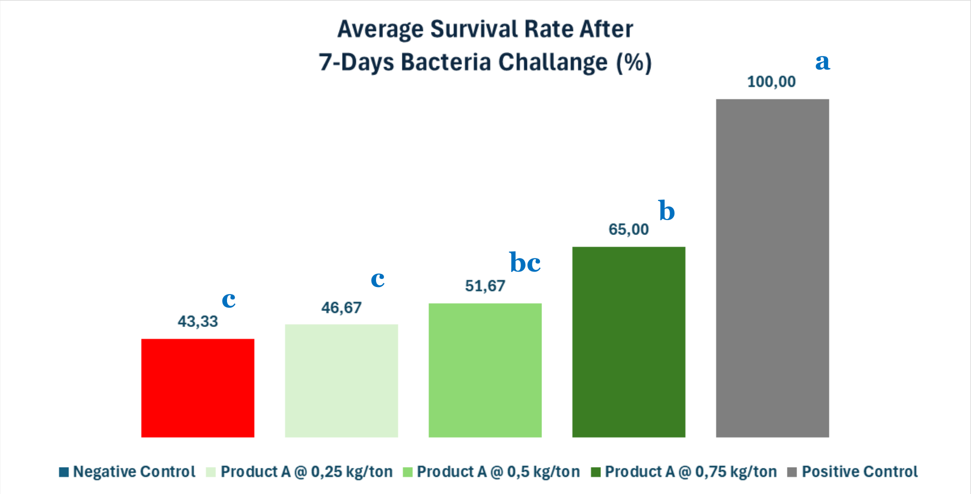
Scientific Trial 02: Kasetsart University, Thailand (2025):

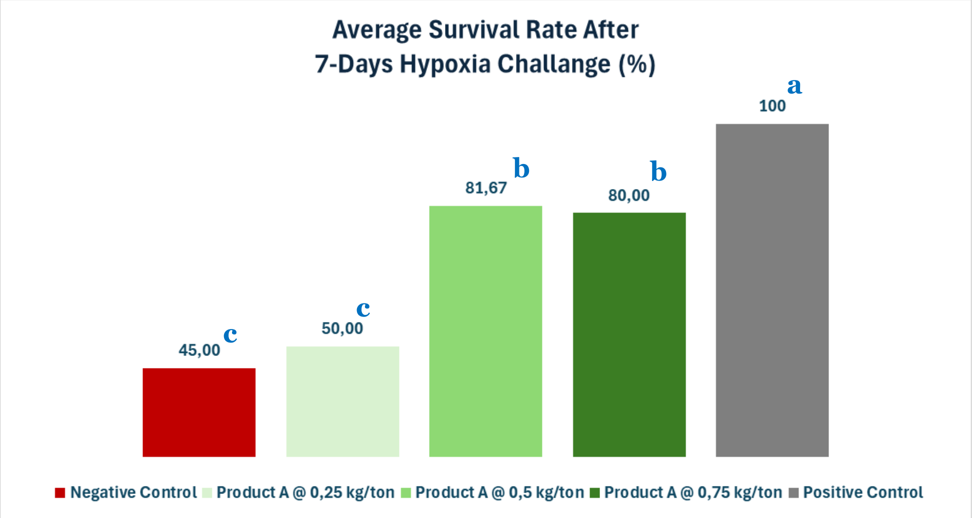
Investigating the Impact of Yeast-Derived Nucleic Acids and Nucleotides Supplementation on Growth Performance, Condition of Hepatopancreas, Immunity, the Total Number of Vibrio spp. in the Gut, Stress Test with Low Oxygen, and Challenged Test with *Vibrio parahaemolyticus* AHPND in Pacific White Shrimp (*Litopenaeus vannamei*)











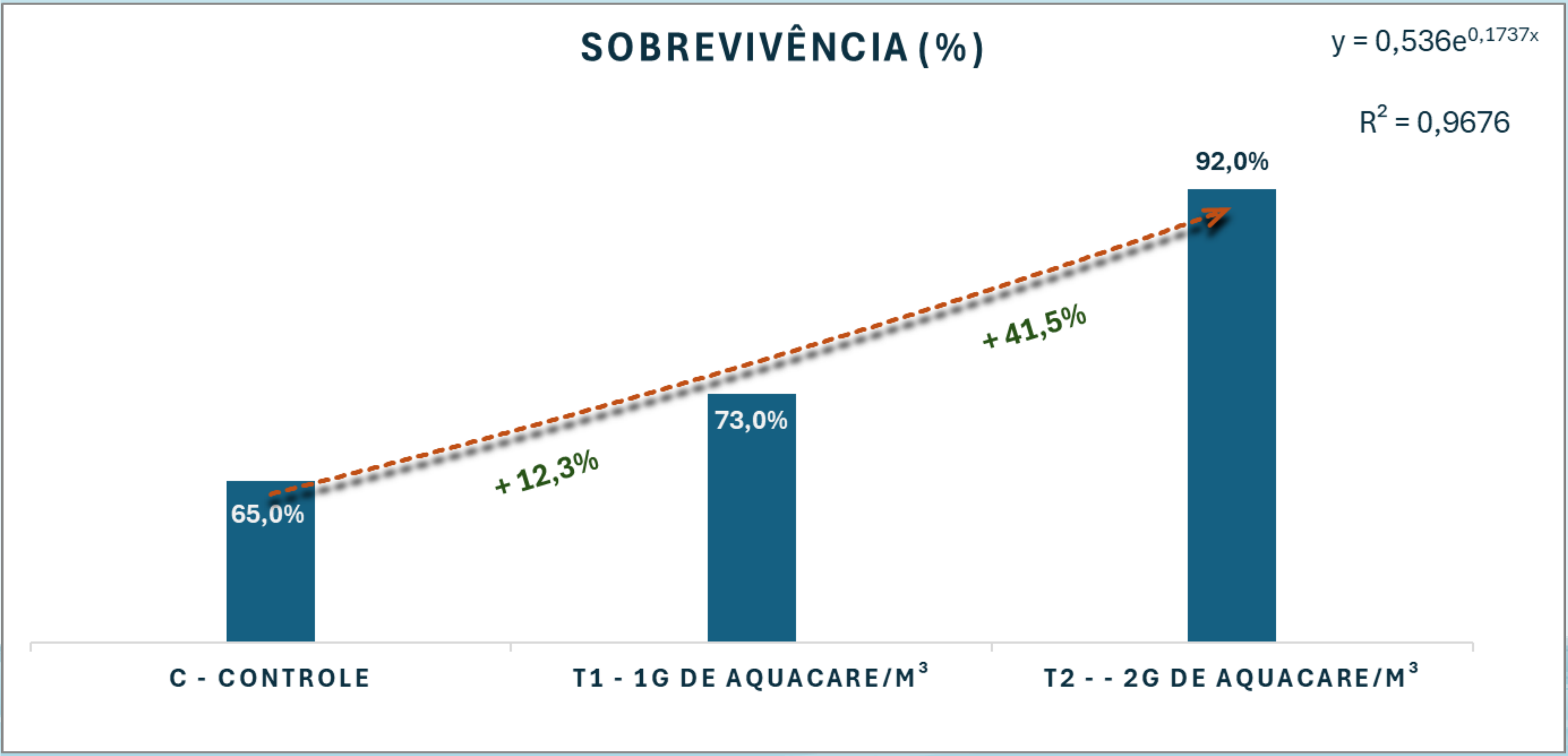
Zootechnical Performance of Penaeus vannamei Post-Larvae (PL_{10} – PL_{16}) during the Acclimation Phase to Oligohaline Water in Intensive Nurseries under Different Application Doses of Nucleotides and Nucleic Acids (RNA).

Survival Rate of *Penaeus vannamei* Post-Larvaes $_{(10\ a\ 16)}$ of *durig the aclimattion Phase*

Water Salinity upon Arrival: 13 ppt

Farms' Underground Water Source: 0,6 ppt

Acclimatation Time in the Nursery Tanks: 6 Days



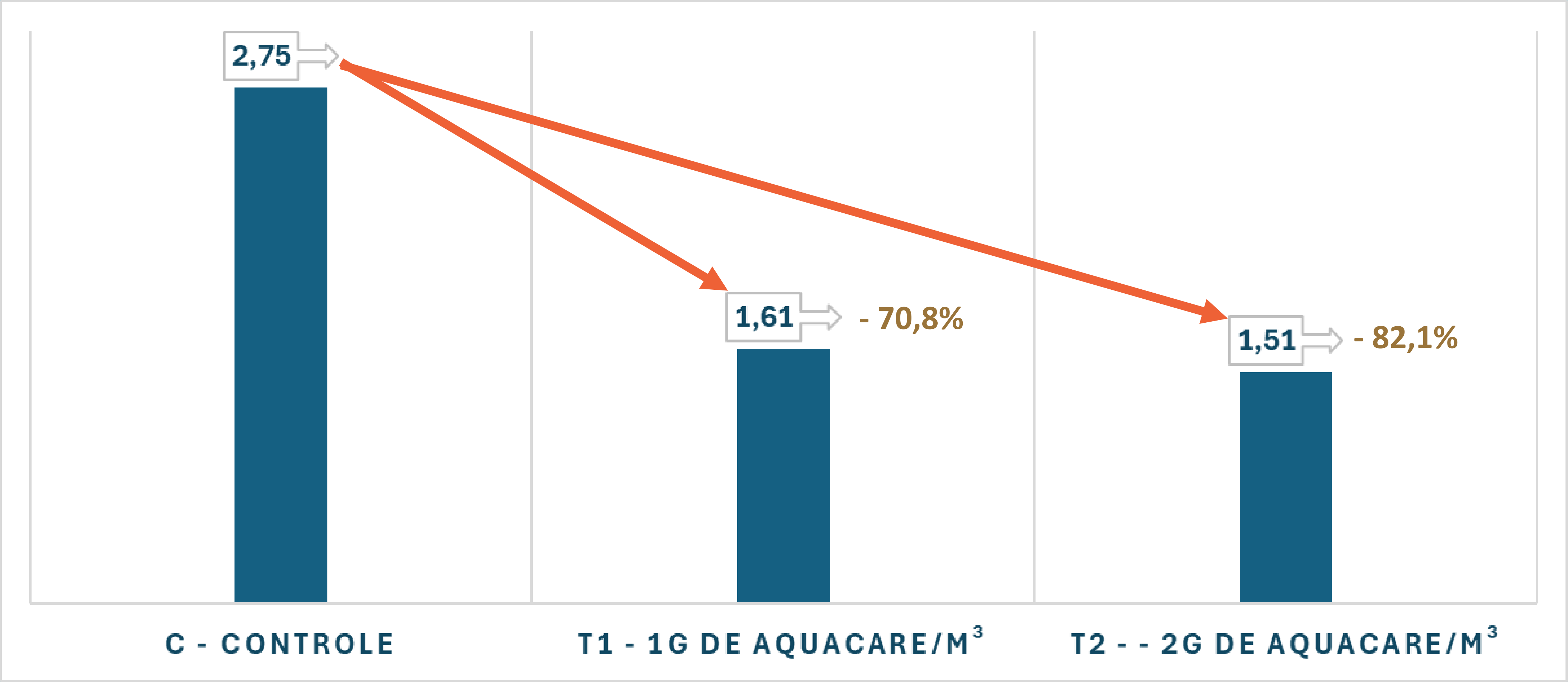
Tanks of 60 m³ <u>Treatments</u>

C - Control

T1 - Product A @ 1 g/m³/day

T2 - Product A @ 2 g/m³/day

FCR


2,75
1,61
- 70,8%
1,51
- 82,1%
C - CONTROLE
T1 - 1G DE AQUACARE/M3
T2 - - 2G DE AQUACARE/M3

Final Biomassa After the Acclimatation Phase