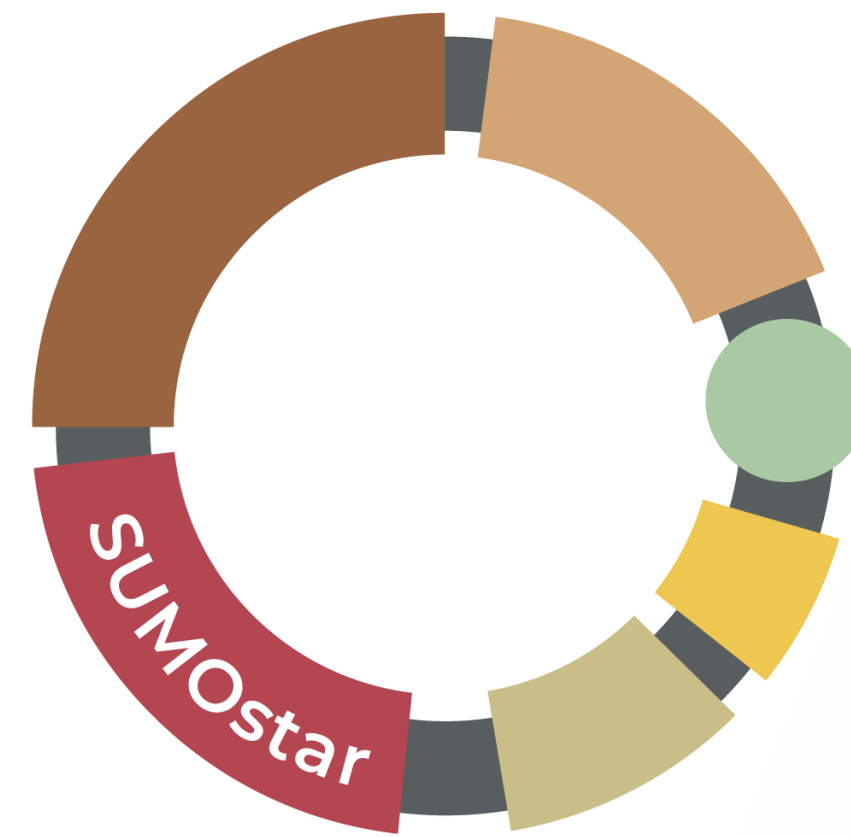


Vaccine Manufacturing as SUMO Fusion



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Changing Vaccine Industry

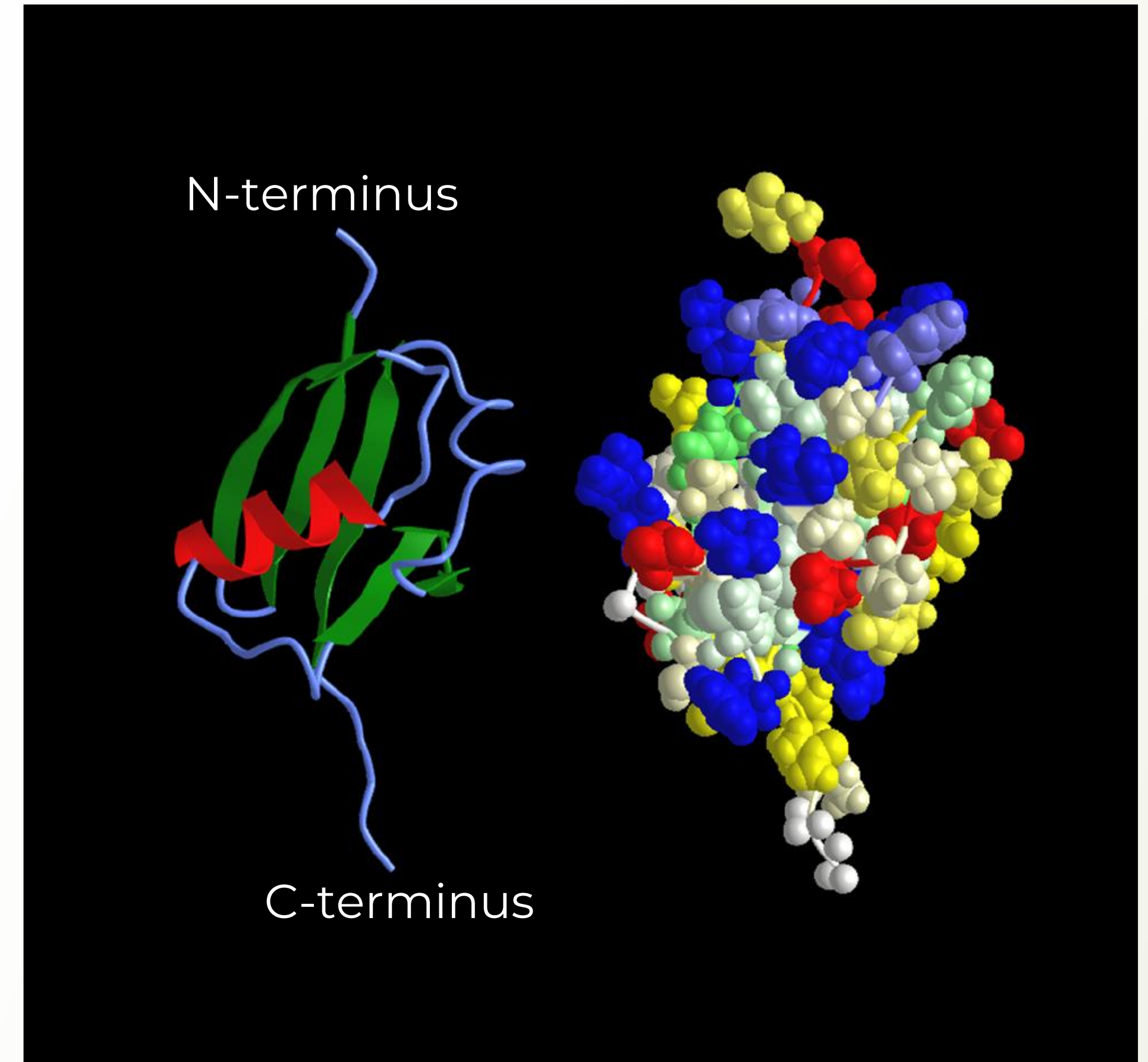
- mRNA COVID-19 vaccine has ushered a new era for mRNA- based vaccine therapies
- Challenge lies in efficiently expressing all the genes for vaccines
- mRNA vaccines are costly and have not been adopted for animal vaccines
- SUMO system dramatically enhances animal vaccine production
- SUMO-vaccines can be delivered as fusion to reduce the cost and simplify the manufacturing process

SUMO Advantage

- **SUMO system dramatically enhances expression, and provides unique features not possible with traditional systems**
- **More than 700 labs have published references therapeutic proteins, peptides, vaccines expressed as SUMO-fusion in E.coli and mammalian cells**

What is SUMO?

- SUMO, or Small Ubiquitin-like modifier, is a member of the ubiquitin family
- SUMO is *not involved* in targeting proteins for degradation
- Flexible N-terminal region followed by a compact ball-shaped ubiquitin-like fold
- Nature designed SUMO to act as a chaperone for proteins
- SUMO improves solubility due to hydrophilic shell and hydrophobic core



Benefits of the SUMO Vaccine Platform

PROBLEMS

Unstable vaccine,
low expression

Correct folding required

Insoluble antigen

High cost of goods



SOLUTIONS

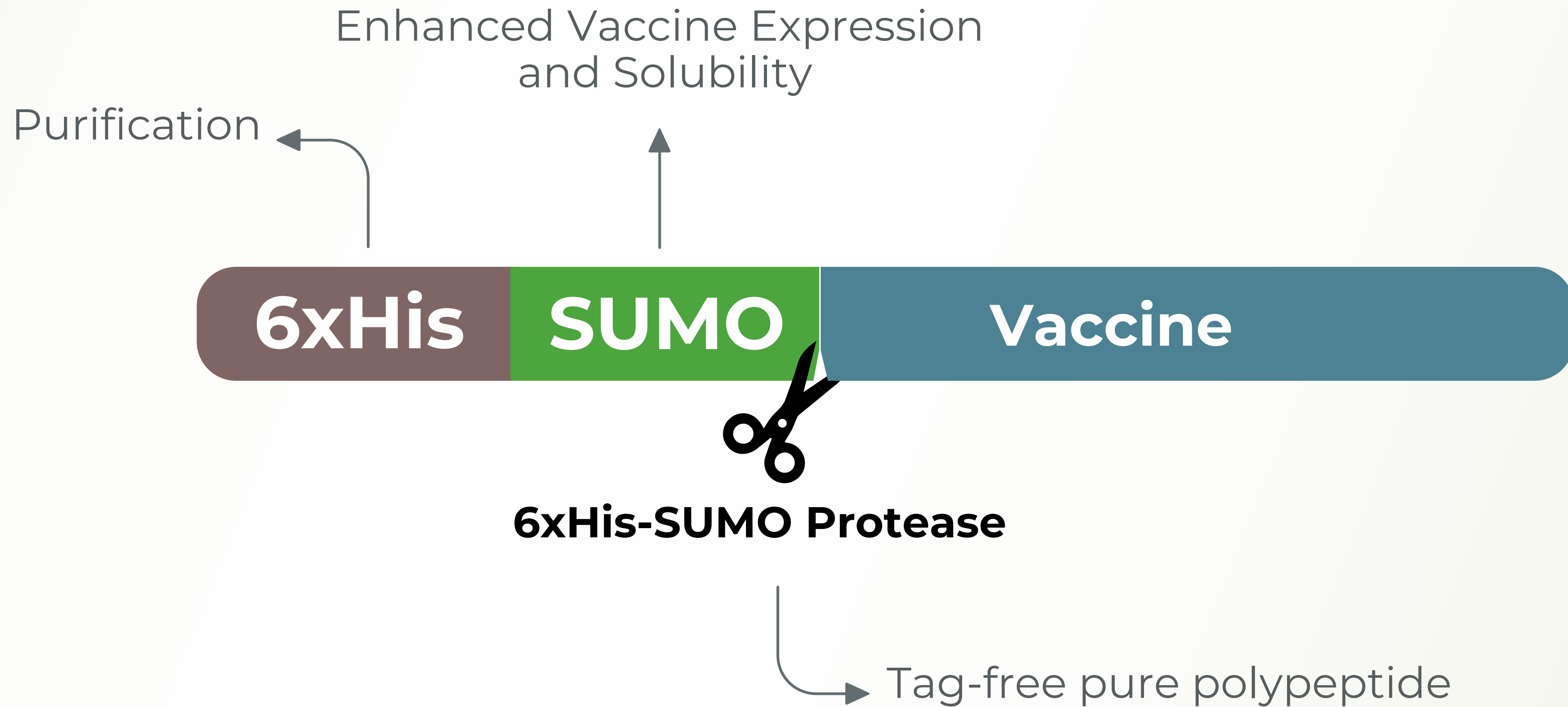
SUMO chaperoning,
enhanced expression

SUMO promoted folding

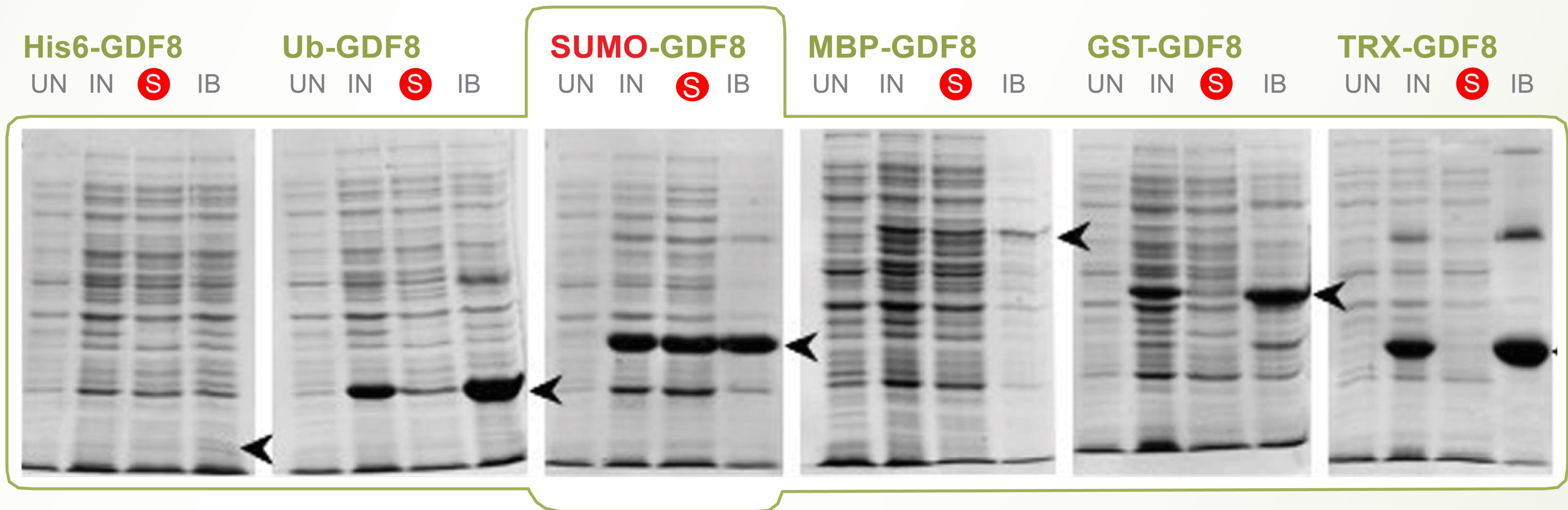
SUMO-driven solubility

High yield, saves cost

SUMO Platform For Vaccines



SUMOpro[®] fusion enhances expression and solubility in *E. coli*



Conditions: UN – Uninduced, IN – Induced, S – Soluble Fraction, IB – Inclusion Bodies

Marblestone et. al, Protein Sci. 2006 Jan;15(1):182-9

Examples of SUMO-enhanced production of Vaccine candidates

Pathogen	Antigen Name	Host	Yield (mg/L)
Salmonella typhimurium	OmpC ¹	E.coli	-
Foot and Mouth Disease Virus (cattle)	Capsid proteins VP0, VP1 and VP3 ^{2,3,4,5,6}	E.coli	15-50 mg/L
SARS-CoV-2	RBD ⁷	E.coli	-
	N protein ⁸	E.coli	-
Porcine circovirus-2	VLP/Capsid protein ⁹	E.coli	-
Human papillomavirus (HPV)	VLP/L1 protein ¹⁰	E.coli	-
Senecavirus A (Pigs)	Capsid proteins VP0, VP1 and VP3/VLP ¹¹	E.coli	-
Zika virus (ZIKV)	Envelope Domain III ¹²	E.coli	-
<i>Trypanosoma cruzi</i> (Chagas disease)	Trypomastigote small surface antigen (gTSSA-I) ¹³	Leishmania tarentolae	-

1. [Prejit et al, Biologicals. 2019](#)

2. [Guo HC et al, Vet Res. 2013](#)

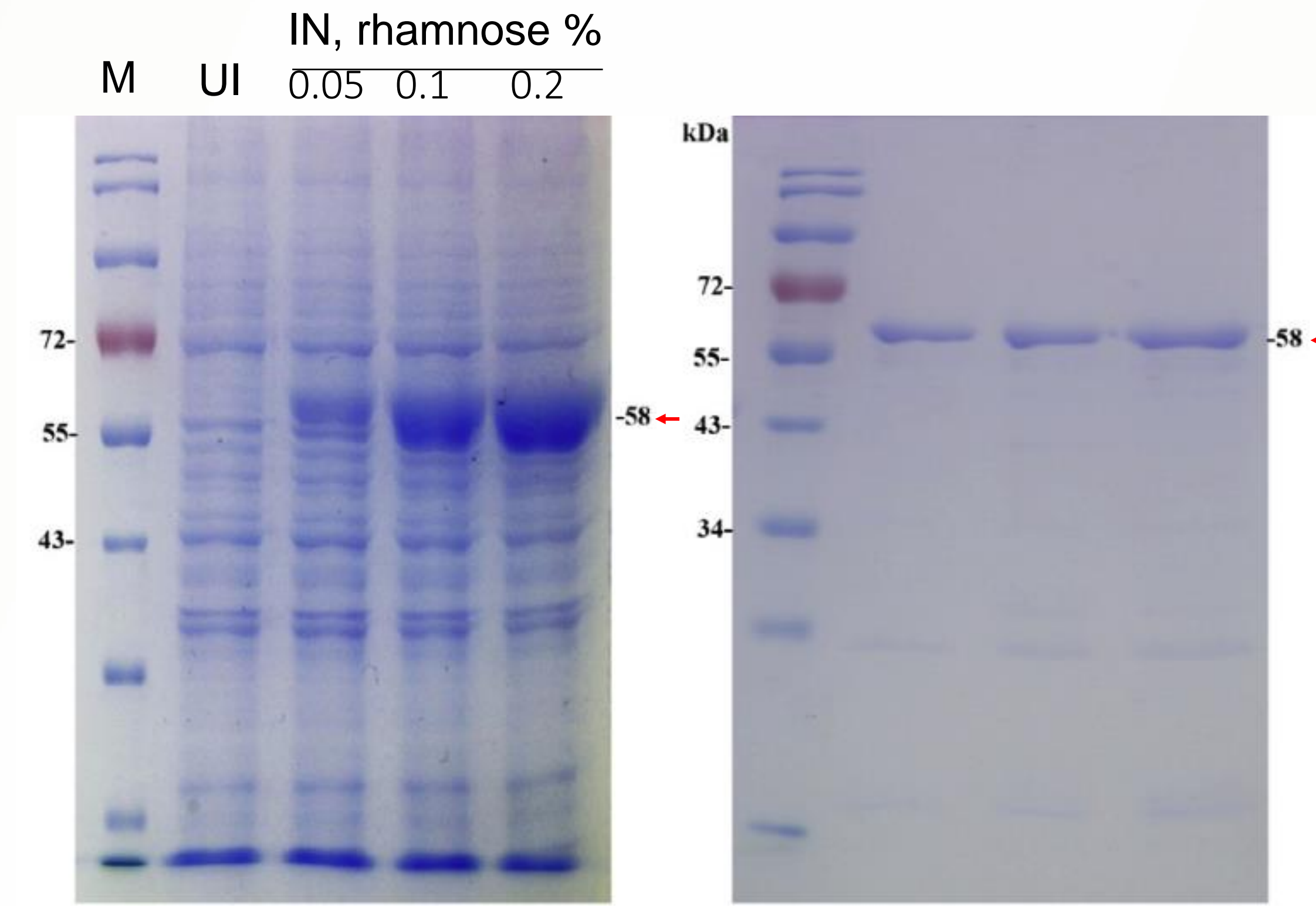
3. [Kim WS et al, Vaccines \(Basel\). 2020](#)

4. [Xiao Y et al, BMC Biotechnol. 2016](#)

5. [Xiao Y et al, Front Vet Sci. 2021](#)

6. [Li H et al, Vaccines \(Basel\). 2021](#)

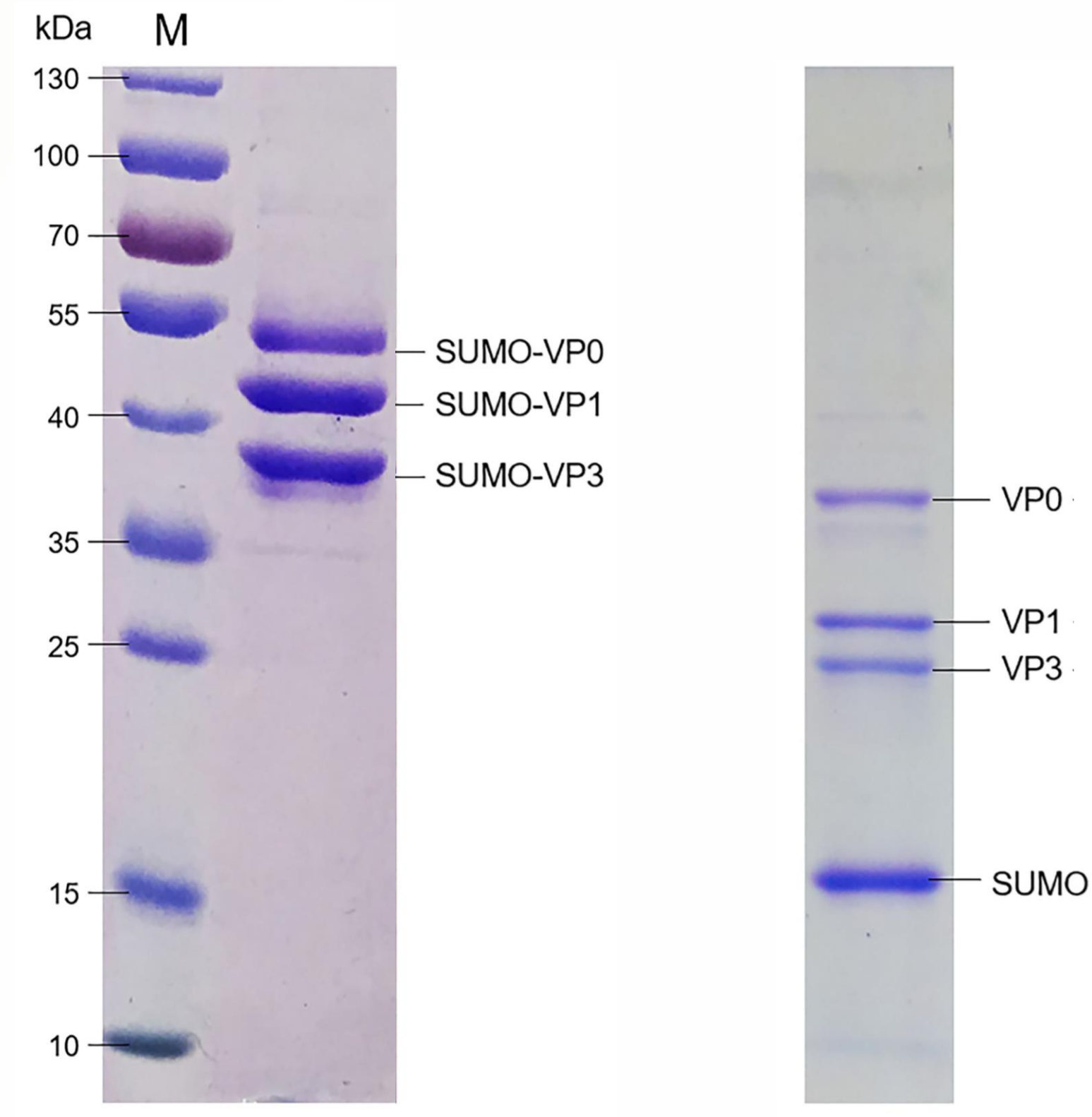
SUMO Enhanced Production of Immunogenic OmpC of *Salmonella typhimurium*



Expression and purification of SUMO-OmpC fusion protein. A. SDS-PAGE analysis of E.coli lysates of the cultures un-induced (UI) and induced with various concentration of rhamnose E.coli cultures. **B.** SDS-PAGE analysis of various amounts of purified SUMO-OmpC fusion protein.

[Prejit et al, Biologicals. 2019](#)

SUMO Enhanced production of immunogenic VLP of Foot and Mouth Disease Virus (FMDV)



Expression and purification of SUMO-fused VLP proteins of FMDV. A. SDS-PAGE analysis of SUMO-VP0, -VP1 and -VP3 **B.** SDS-PAGE analysis of SUMO-cleaved VP0, VP1 and VP3.

[Xiao Y et al, Front Vet Sci. 2021](#)

Advantage of SUMO Vaccine

- **Dramatic enhancement of vaccine production in prokaryotes**
- **Highly attractive for veterinary vaccine applications**
- **SUMO protein highly conserved, low immunogenicity**
- **Choice of cleaving SUMO or vaccinate as SUMO-fusion**
- **Simple manufacturing process, low cost of goods**

Thank You

We are your partner in Manufacturing Proteins

Contact Us!

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