

Seed Composition and Amino Acid Profiles for Quinoa Accessions Grown in Washington State

Evan B. Craine and Kevin M. Murphy

Sustainable Seed Systems Lab

Department of Crop and Soil Sciences – Washington State University

C1/C9 Breeding for Improved Nutrition to Feed the World Oral



Translating Visionary Science to Practice

Overview

Introduction to Quinoa

Part 1: Amino Acid Study

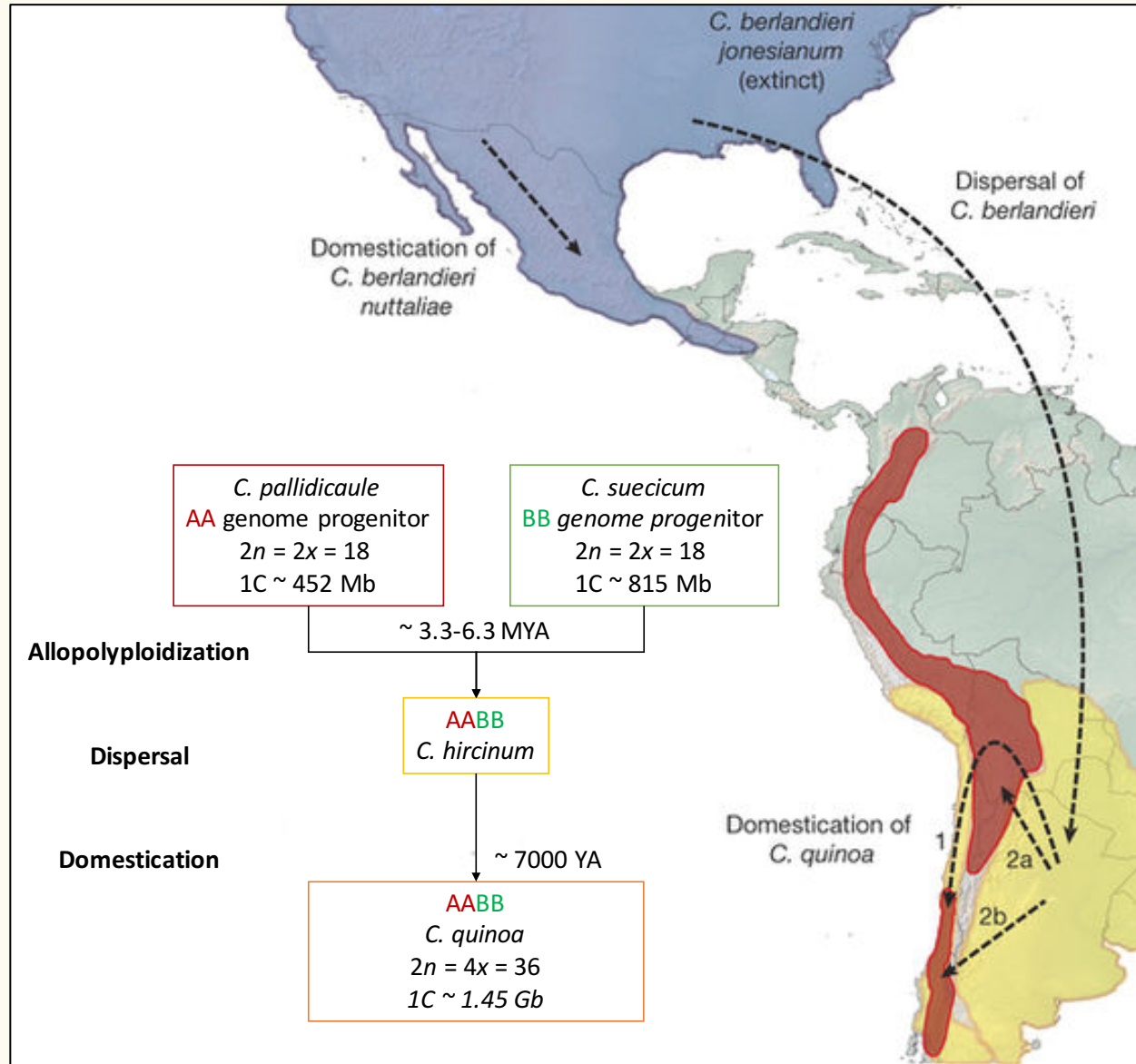
Part 2: NIR calibration and application



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Domestication & Diversification



Jarvis et al. (2017)
Maughan et al. (2004; 2016)
Wilson and Manhart (1993)

KAUST
Elodie Rey
Mark Tester

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Quinoa as a Keystone Protein Crop for Global Food Security

Murphy et al. (2016)



Photo by Julianne Kellogg

- Quinoa is gaining worldwide attention, leading to a rapid expansion
- Excellent nutritional quality & potential to improve global food security, especially in marginal environments

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ORIGINAL RESEARCH ARTICLE

Front. Nutr., 12 August 2020 | <https://doi.org/10.3389/fnut.2020.00126>



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 Evan B. Craine and  Kevin M. Murphy*

Department of Crop and Soil Sciences, Washington State University, Pullman, WA, United States

1. Provide a baseline for nutritional quality of Washington grown quinoa
2. Test the hypothesis that these samples contain adequate amounts of essential amino acids to meet daily requirements set by the World Health Organization (WHO)

Photo by Jullianne Kellogg



Sample Selection

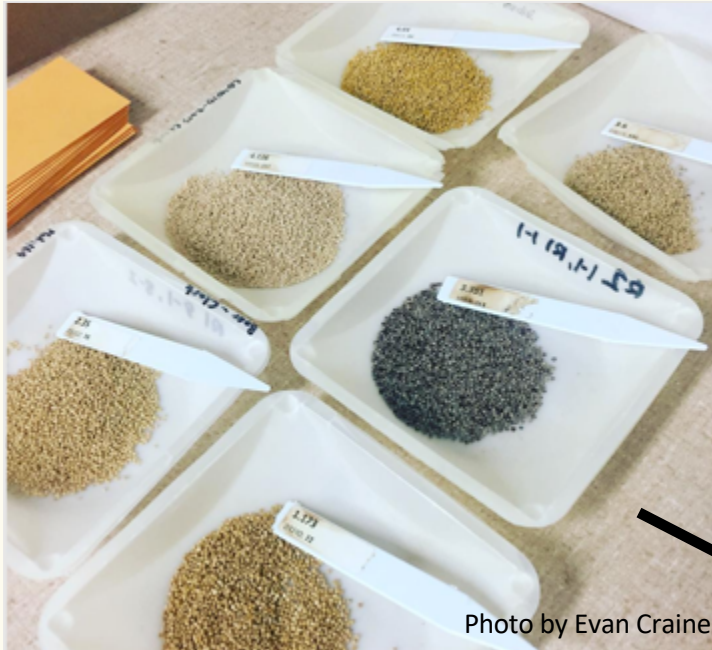
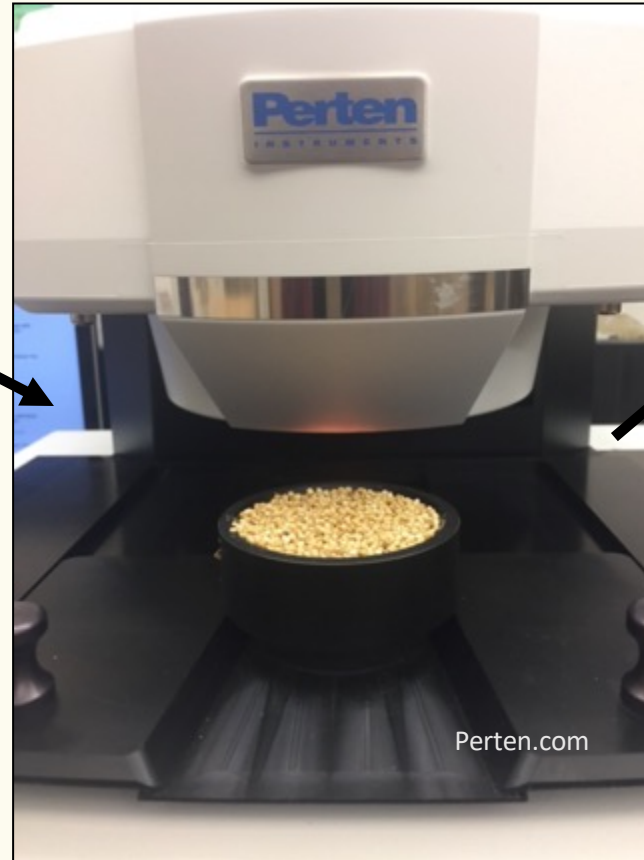
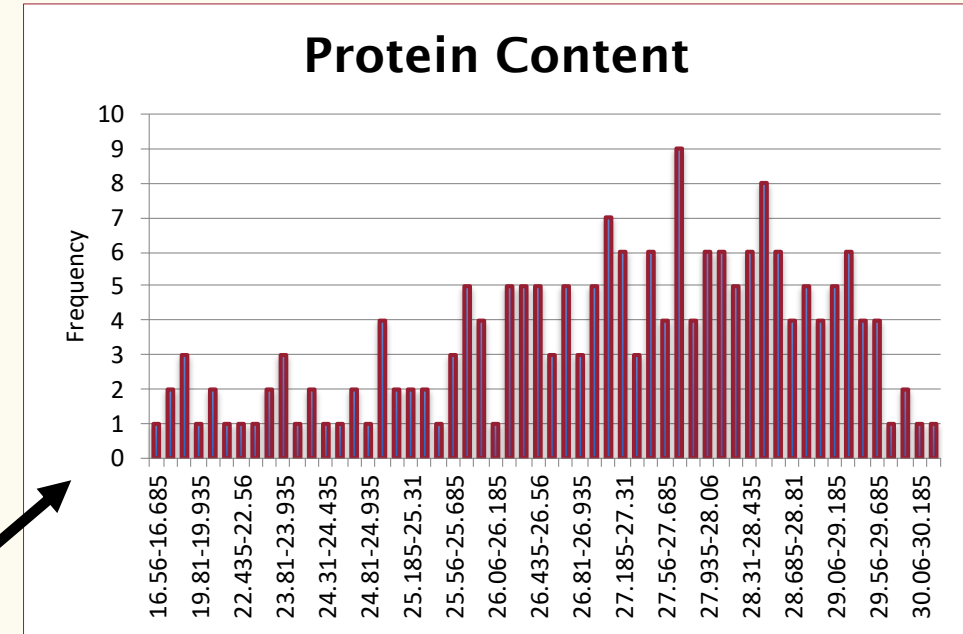


Photo by Evan Craine

200 samples of WA grown quinoa



Perten.com



100 samples randomly selected across distribution



Germplasm

- F5:F6 advanced breeding lines (n=85)
 - 6 biparental populations from 2013
- Varieties/landraces (n=15)



Photo by Julianne Kellogg

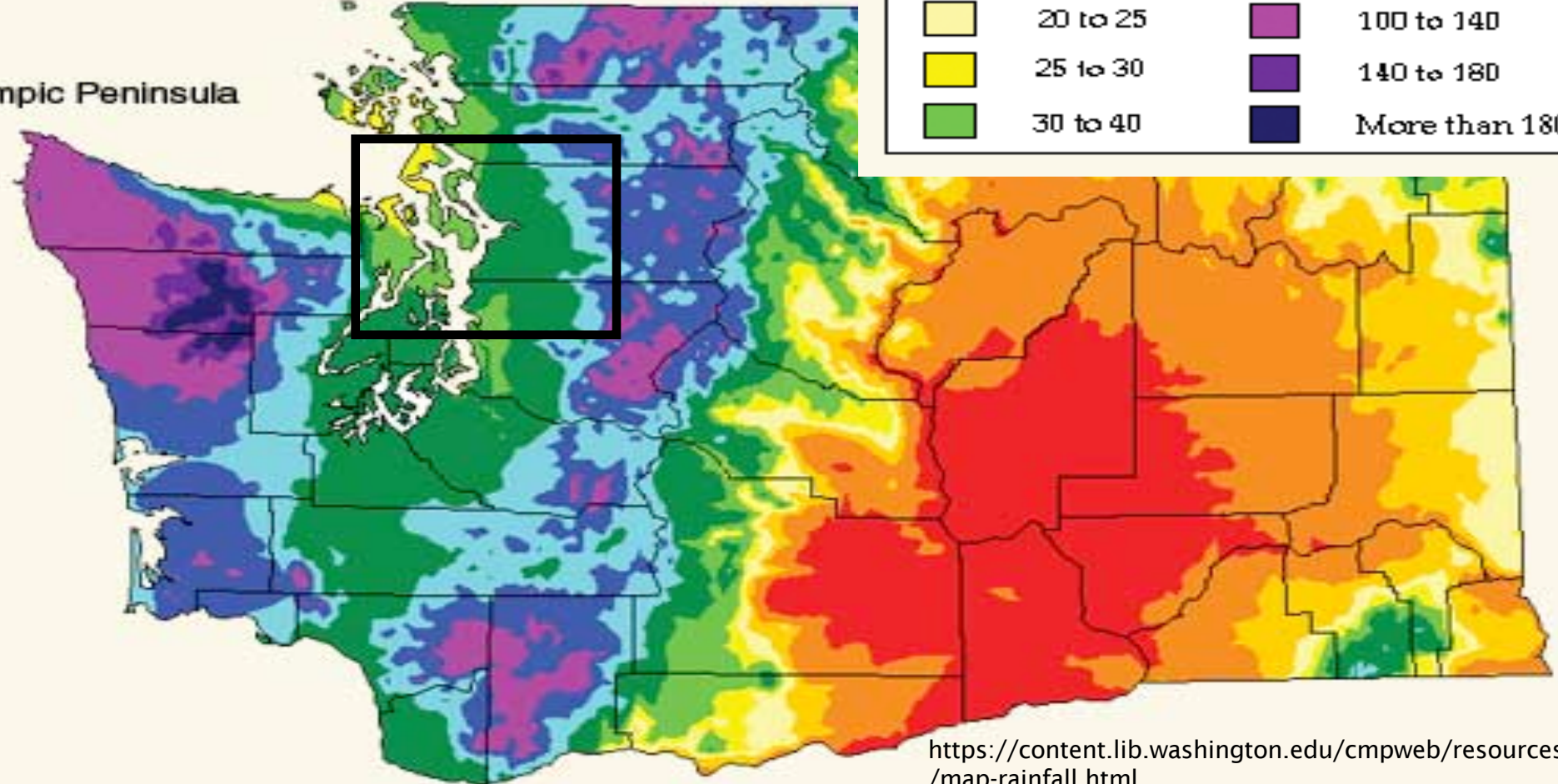


Locations



<http://ontheworldmap.com/washington-location-on-the-map>

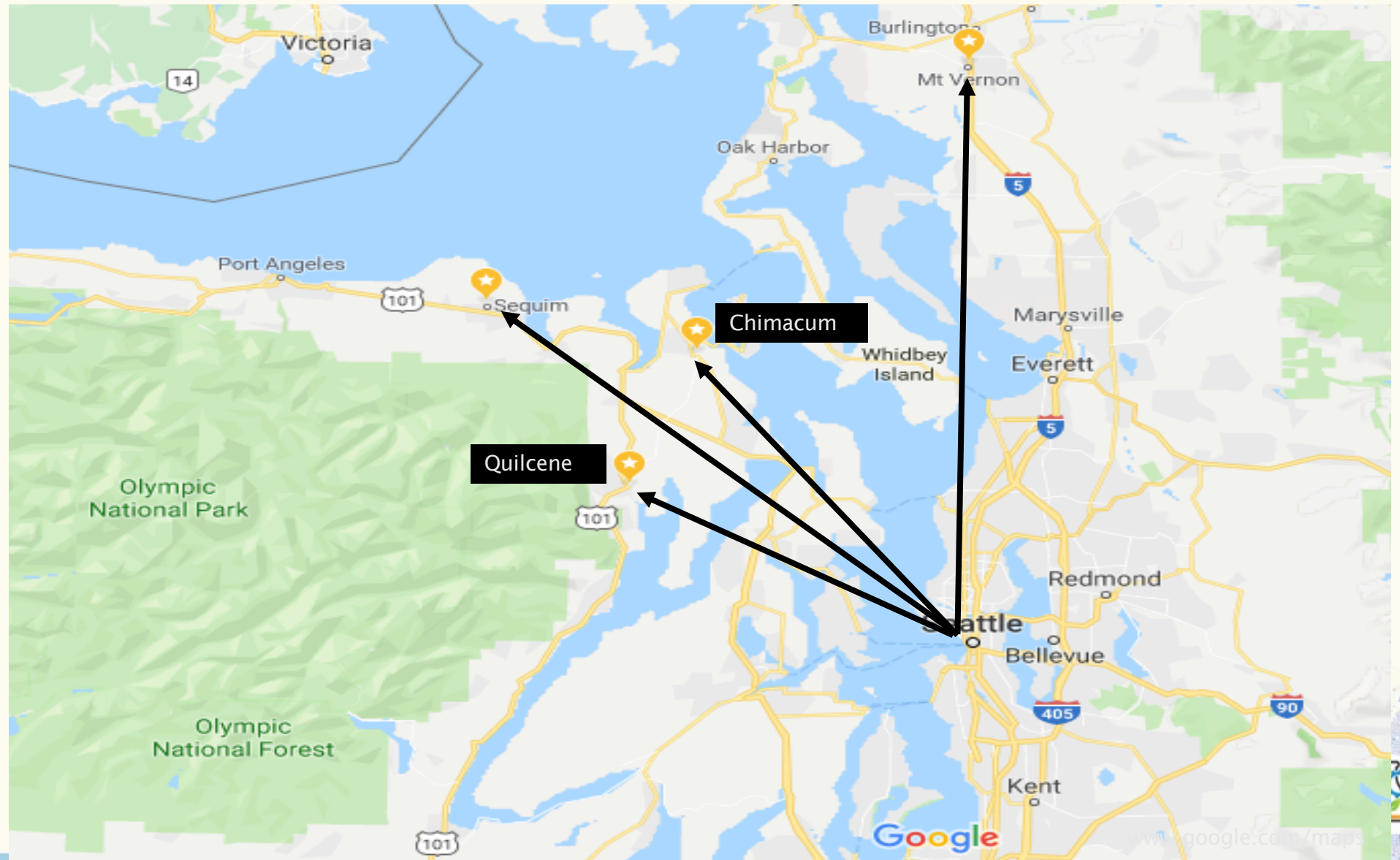
Olympic Peninsula



<https://content.lib.washington.edu/cmpweb/resources/map-rainfall.html>

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Locations



Wet Chemistry

- 30g of raw, whole grain samples sent for analysis
 - ground into a flour before analysis

Complete **Amino Acid Profile** (AAP) (n=23)

Seed Composition Components

- **Crude Protein:** total nitrogen x 6.25
- **Ash**
- **Crude Fat**
- **Moisture**
- **Total Carbohydrates**, crude 'by difference'



Agricultural Experiment Station

University of Missouri-Columbia

College of Agriculture, Food and Natural Resources

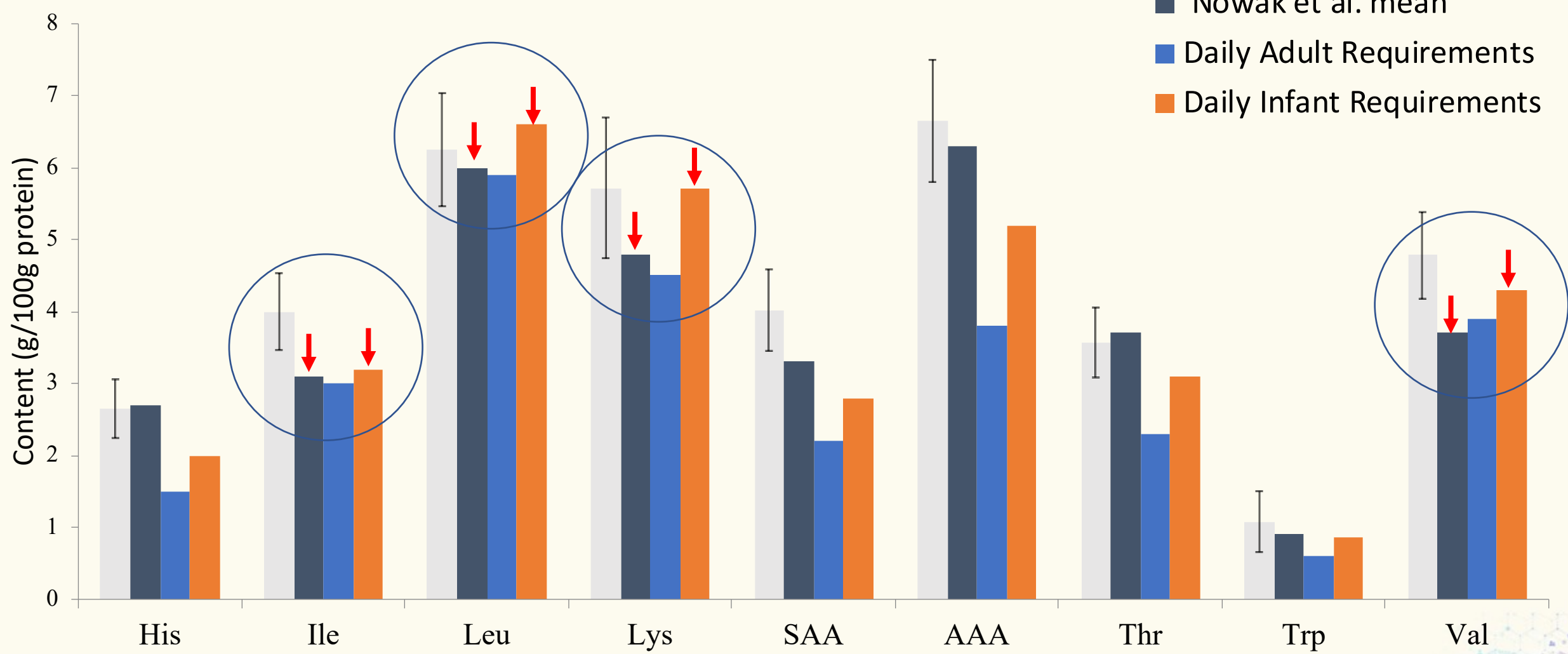
Chemical Laboratories



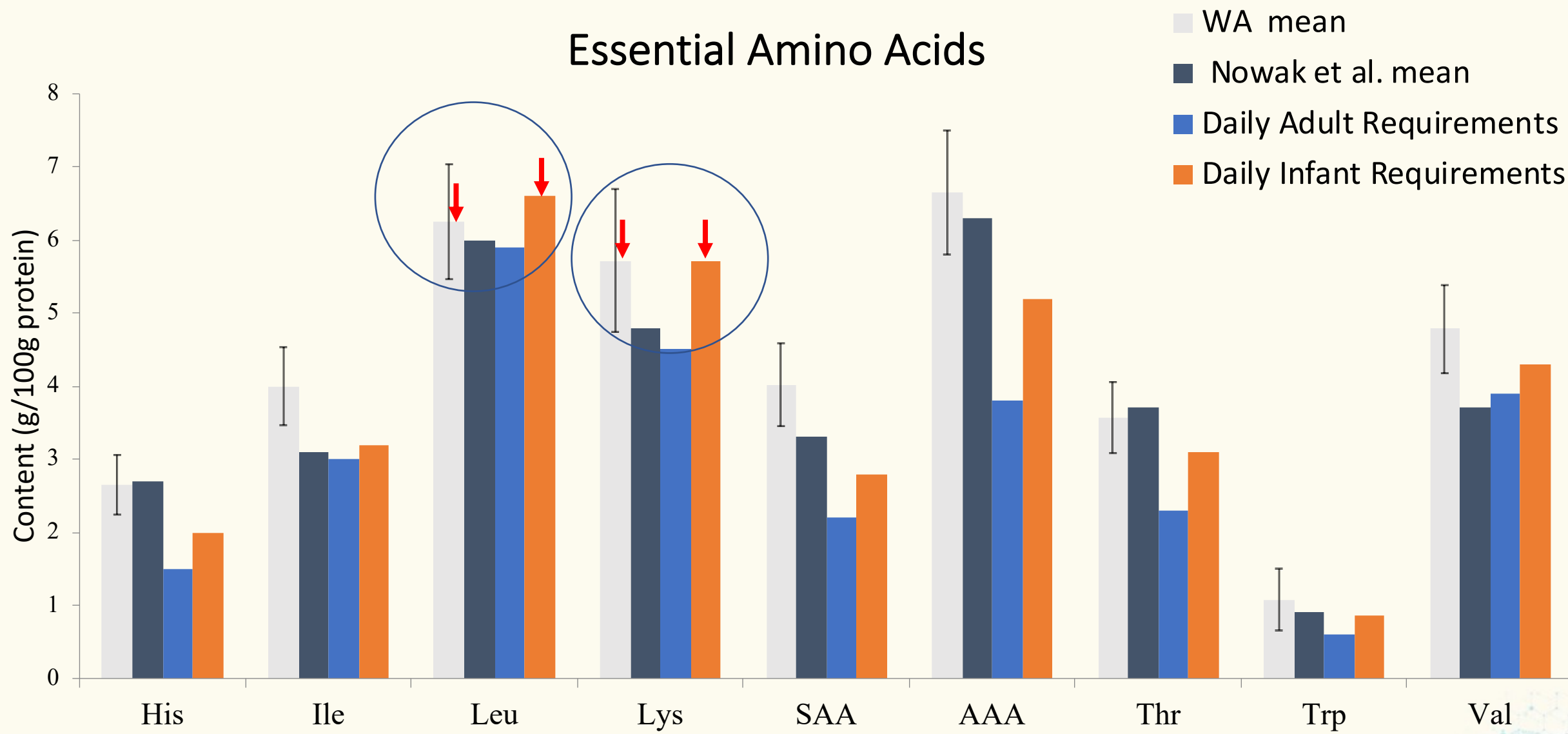
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Essential Amino Acids



Essential Amino Acids

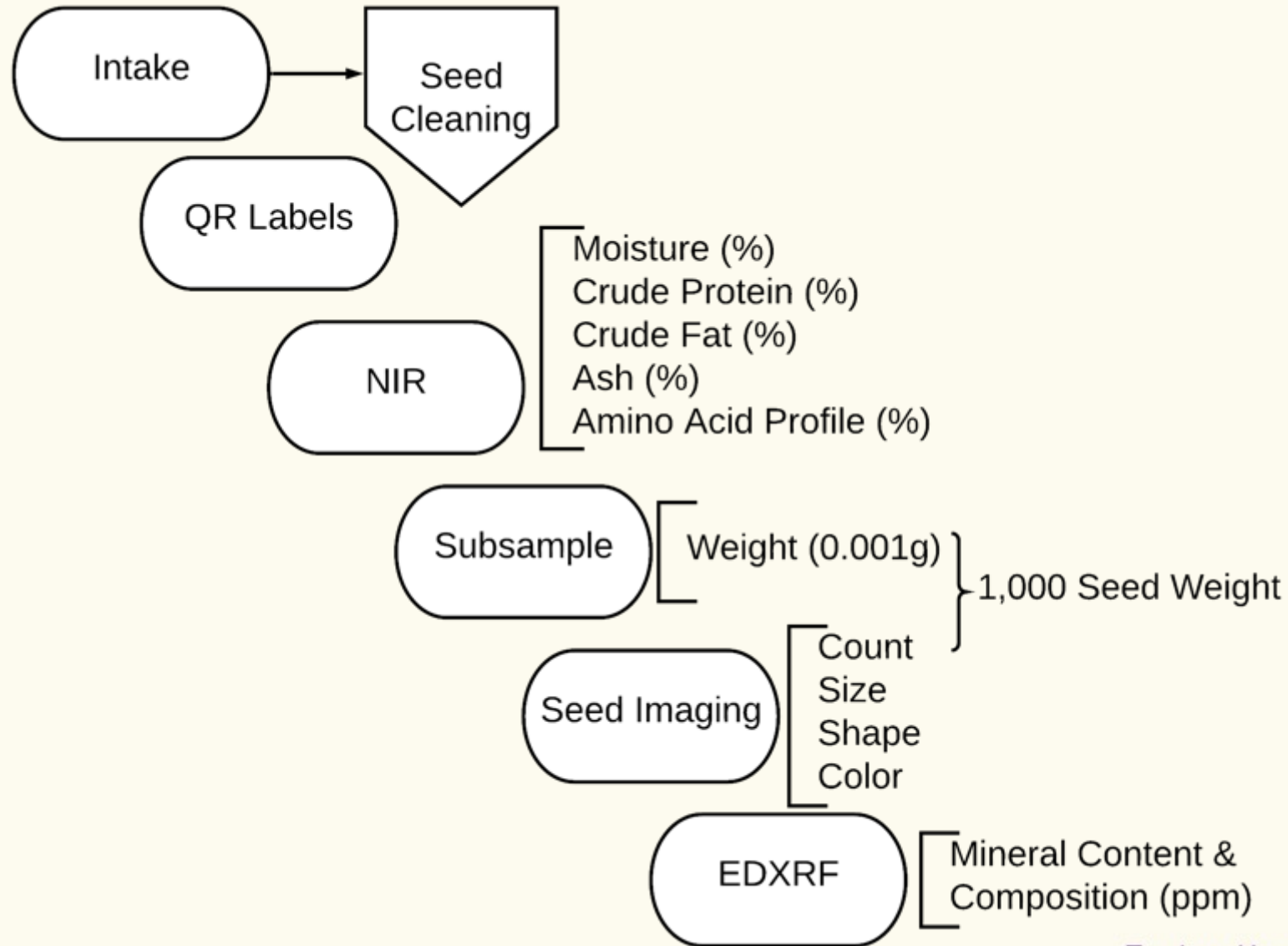


Summary

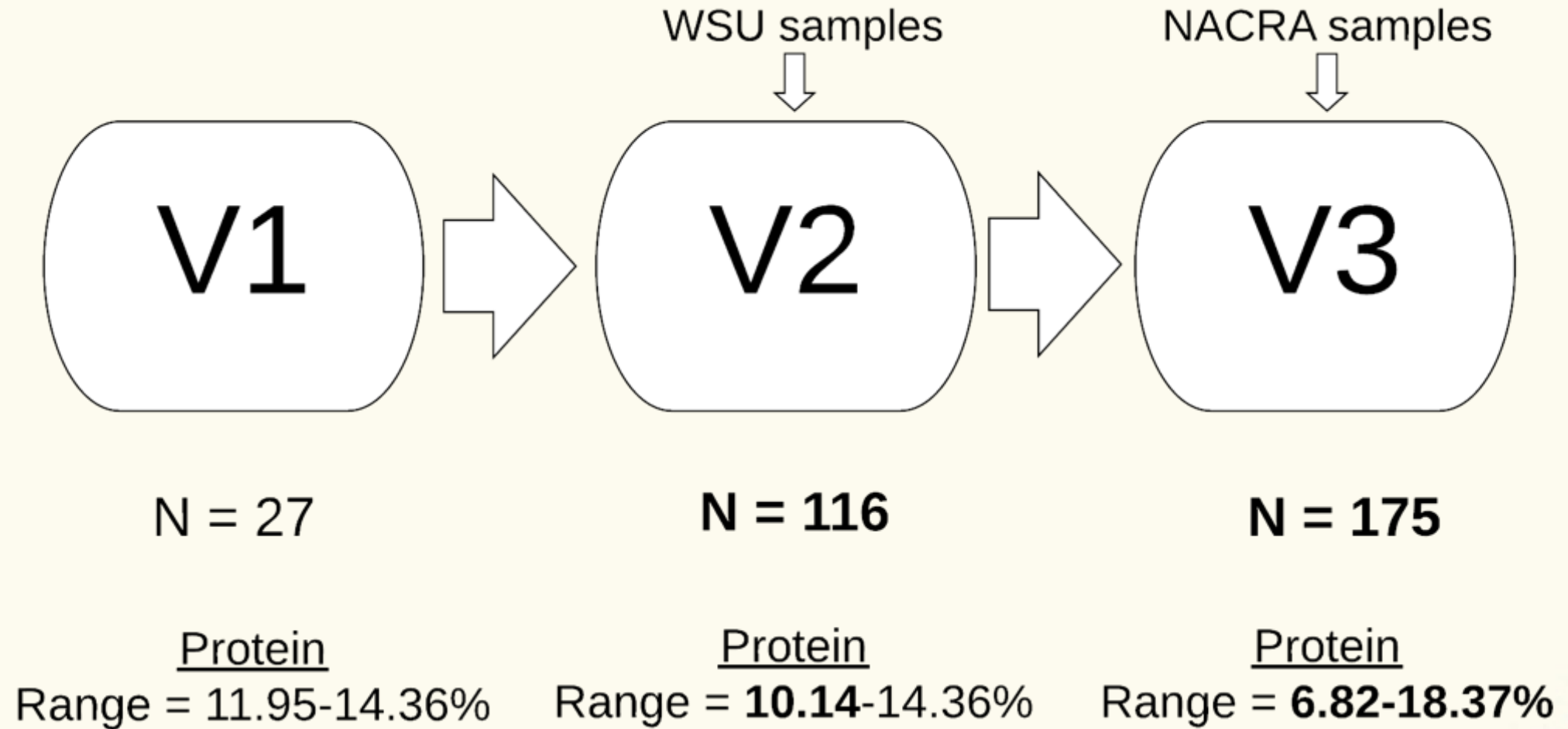
- Testing the universality of the claim that quinoa is a complete protein
- Observed **lower protein content**, but **high protein quality**
 - Higher value for 7/9 essential AA compared to Nowak *et al.*, 2016
- **Nowak *et al.*, 2016** mean values **do not meet**:
 - Adult and infant requirements: Val
 - Infant requirements: Ile, Leu, Lys
- **WA samples**:
 - Mean value for Leu does not meet infant requirements
 - 9% meet all requirements for Leu
 - 52% meet all requirements for Lys
 - 94% meet all requirements for Trp
- Evidence of possible genotype-dependent G X E interactions



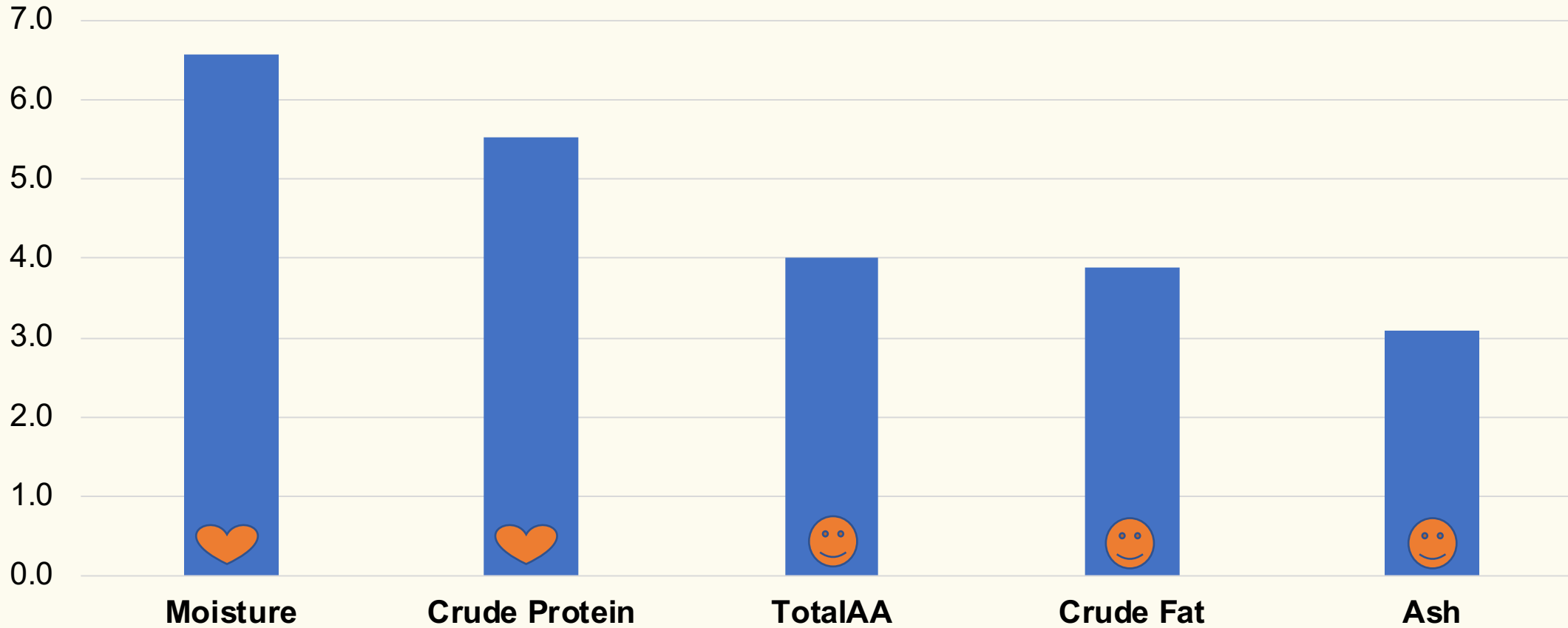
WSU Nutritional Phenotyping Pipeline




NIR Calibration Development




RPDCV Seed Components



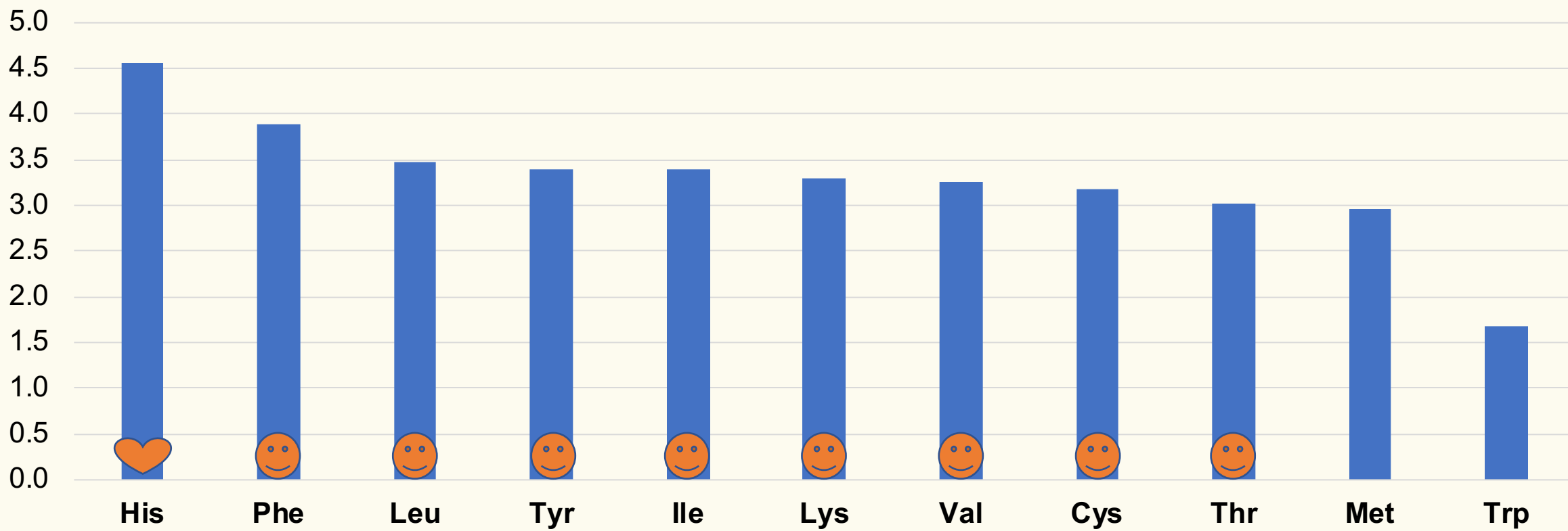
$$\text{RPDCV} = \frac{\text{standard deviation reference data}}{\text{standard error of cross validation (or prediction)}}$$

 **Excellent:** RPD > 4 & R2 > 0.95
Quality Measurement: RPD 5-8


 **Good:** RPD = 3–4 & R2 = 0.9–0.95
Screening & Ranking: RPD 3-5


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RPDCV Essential Amino Acids



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Acknowledgments

Lab Members (current)

- Dr. Kevin Murphy (PI)
- Dr. Dan Packer (Research Associate)
- Dr. Cedric Habiyaremye (Research Associate)
- Julianne Kellogg

Lab Members (former)

- Halle Choi
- Dr. Leonardo Hinojosa Sanchez
- Adam Peterson

Perten Instruments

- Ryan Bishop
- David Honigs



Grant Number 2016-51300-25808



Search "Postharvest Phenotyping" on YouTube

Search "Nutritional Phenotyping Pipeline" on YouTube

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Extra Slides



Protein Digestibility-Corrected Amino Acid Score

WHO, 1991

Source	PDCAAS
Milk ^a	1.00
Whey ^a	1.00
Egg ^a	1.00
Beef ^a	0.92
Soya ^a	0.91
Quinoa (raw) ^b	0.86
Quinoa (washed) ^b	0.85
Quinoa (boiled) ^c	0.72
Pea ^a	0.67
Oat ^a	0.57
Whole wheat ^a	0.45

- Actual amount of amino acid/reference
 - Amino Acid Score (**AAS**)
- Lowest Amino Acid x Protein Digestibility

“A nearly complete protein”

- AAA, Thr, Lys (Ruales and Nair, 1992)
 - Met & Trp (Mahoney et al., 1975)
- *certain amino acids in limiting amounts*

^aSchaafsma, 2000 ^bRuales and Nair 1992 ^cMahoney et al. 1975

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Comparing Literature Review to Daily Requirements

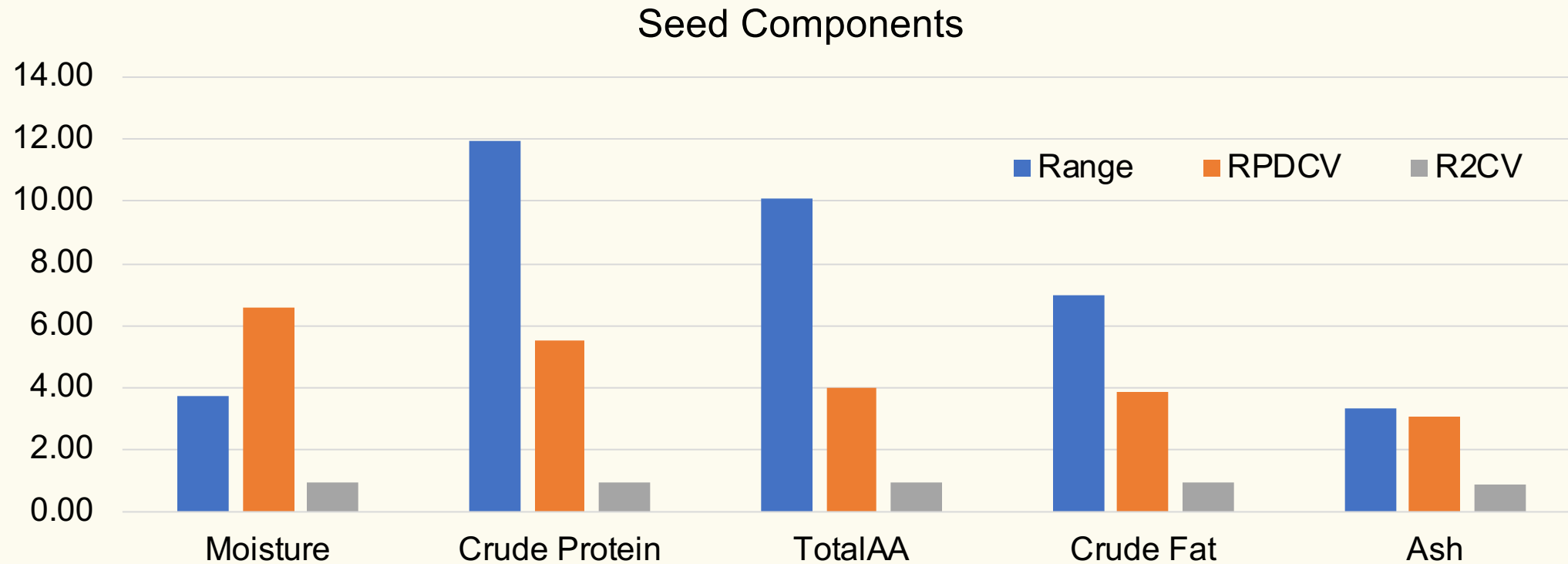
	His	Ile	Leu	Lys	Met	Cys	Phe + Tyr	Thr	Trp	Val
Infant	2	3.2	6.6	5.7	2.04	0.76	5.2	3.1	0.85	4.3
3-10	1.6	3.1	6.1	4.8	1.75	0.65	4.1	2.5	0.66	4
Adult	1.5	3	5.9	4.5	1.6	0.6	3.8	2.3	0.6	3.9
Quinoa, raw mean	2.7	3.1	6	4.8	1.9	1.4	6.3	3.7	0.9	3.7
Min-Max	1.4-5.1	0.8-7.4	2.3-9.4	2.4-7.8	0.3-9.1	0.1-2.7	2.7-10.3	2.1-8.9	0.6-1.9	0.8-6.1
n	42	42	42	42	41	11	41	42	27	42

Adapted from Nowak et al. 2016

Suggested patterns of requirements for each age group reported as g/100g protein (WHO/FAO/UNU, 2007)



V3 CALIBRATION METRICS

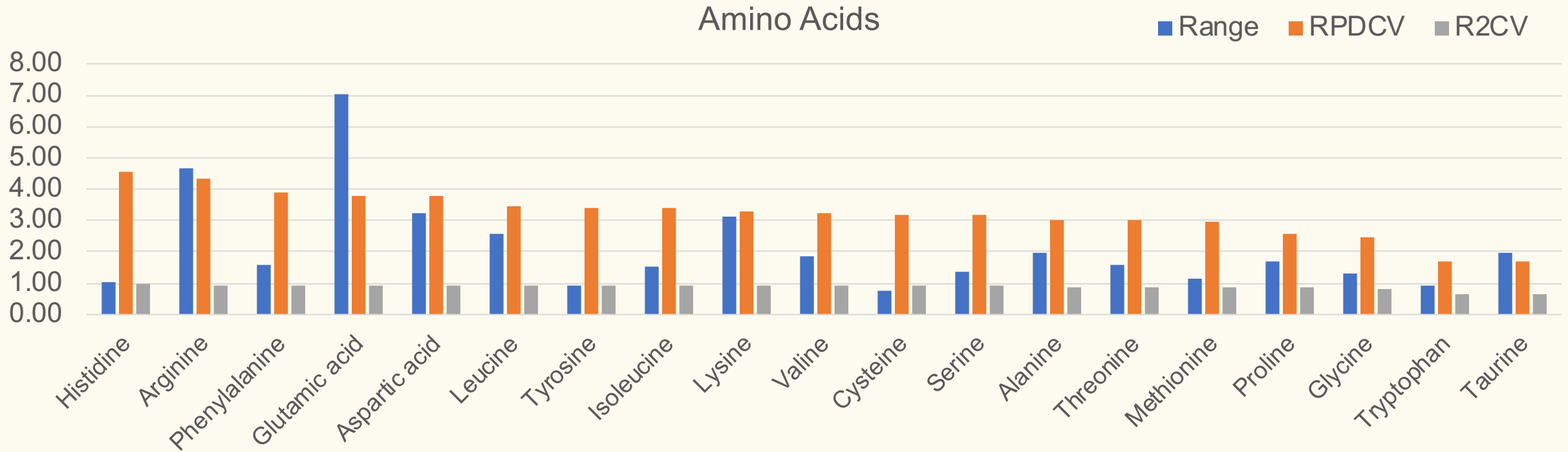


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RPD 3-5 = screening
RPD 5-8 = quality measurement



V3 Calibration Metrics



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