McGill

Proyecto SAN Nariño
Food Security and Nutition

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SEDE BOGOTÁ

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Exploring biodiversity to introduce nutritional quality criteria in potato breeding program

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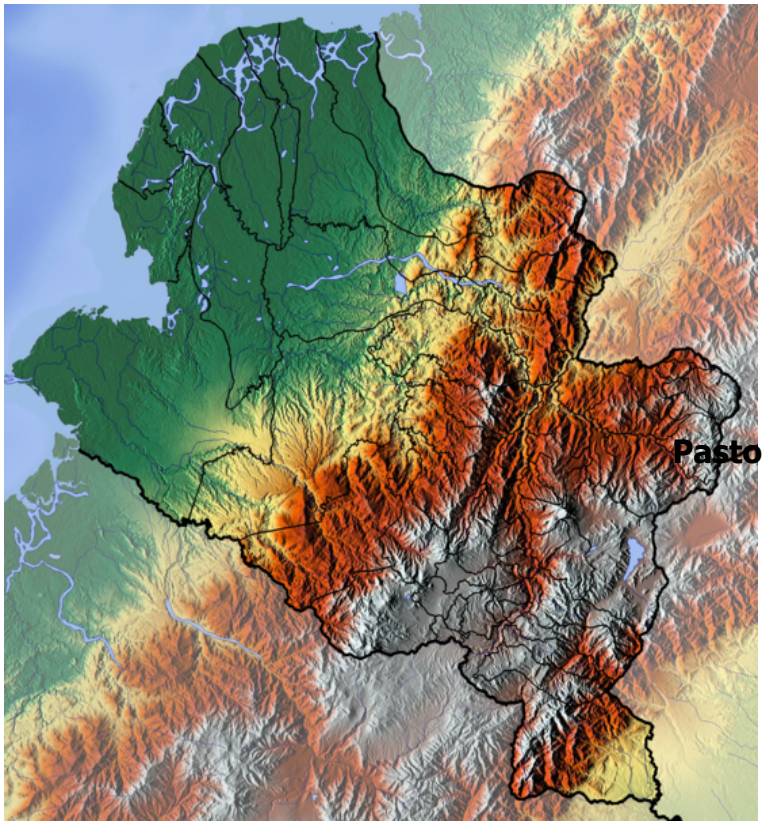
1. Introduction

Where are we working?

Working with Andean communities



Why are we working in nutritional quality?

- Nariño is the second undernourished province in Colombia.
- High percentage of food insecurity.
- 21.5% of the population younger than five years suffers malnutrition.
- There is not accurate data to design public policies about food security and nutrition.
- Breeding programs have not considered nutritional quality criteria for selecting new cultivars.
- Nariño is a potato biodiversity center.

Food security is built on three pillars

1. **Food use:**
appropriate use based on knowledge of basic nutrition and care, as well as adequate water and sanitation.

2. **Food availability:**
sufficient quantities of food available on a consistent basis.

3. **Food access:**
having sufficient resources to obtain appropriate foods for a nutritious diet.

We have worked on:

- Nutritional status of the population.
- Analysis of potato intake.

- Analysis of nutritional quality for potato tubers.
- Producing tuber seeds of good quality for potato production.

- Delivering new potato cultivars, with high yield and reducing costs.

2. Objective

Photo: Ernesto Rodríguez

Improve food security in indigenous communities by selection of potato cultivars with high yield and nutritional qualities to improve their daily diet.

3. General methodology

Social study
Nutritional analysis for population

Food consumption pattern

Nutritional status of population

Advanced technologies
Nutritional quality of potatoes

Biochemical analysis

- Micronutrientes
- Macronutrients
- Polyphenols

Functional analysis

- Metabolomics: metabolites
- Biotransformation and bioaccessibility

Potato breeding program

New potato cultivars with better nutritional quality

4. Results

4.1. Nutritional status of the population

Percentage of boys and girls under nutritional standards

Nutritional situation by anthropometry	Boys	Girls
Stunting	41.6	30.8
Overweight	23.4	44.4
Obesity	18.0	7.0
Underweight	3.1	1.8

Percentage of the population with deficient intake

Age groups	Calories	Proteins	Minerals			Vitamins	
			Fe	Zn	Ca	A	C
Under 5	56.6	15.8	21.8	81.6	50.8	45.7	5.9
From 5 to 12 years	73.8	33.2	26.1	91.0	92.1	72.5	17.3
Adults	88	85.1	42.7	99.8	91.9	87.9	42.7
Total	72.9	41.9	29.0	91.1	82.7	70.4	20.8

Samples preparation for the analysis

Planting and harvesting

Clasification and washing

Cooking according to the tuber size

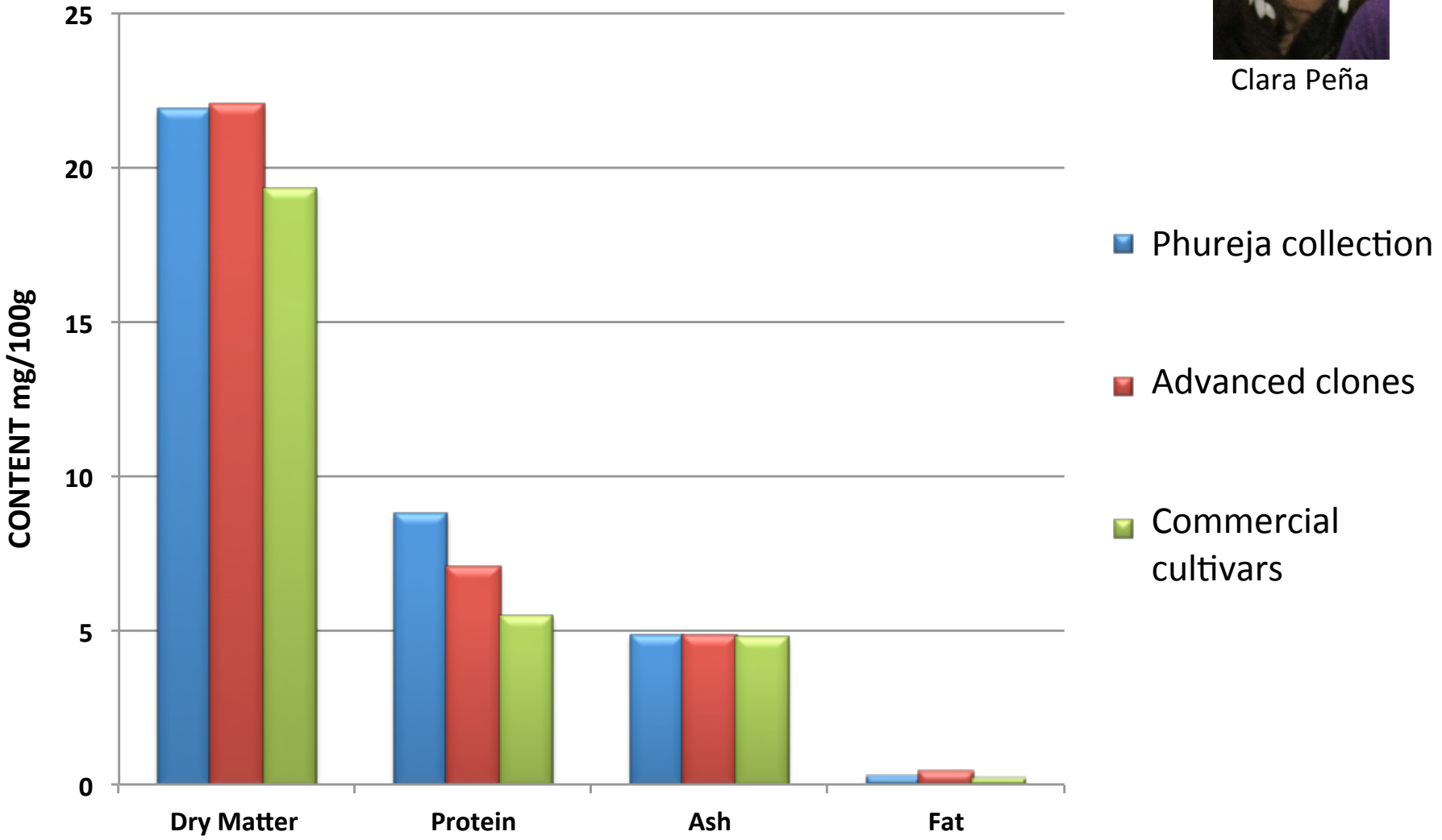
Cutting in slides

Lyophilization

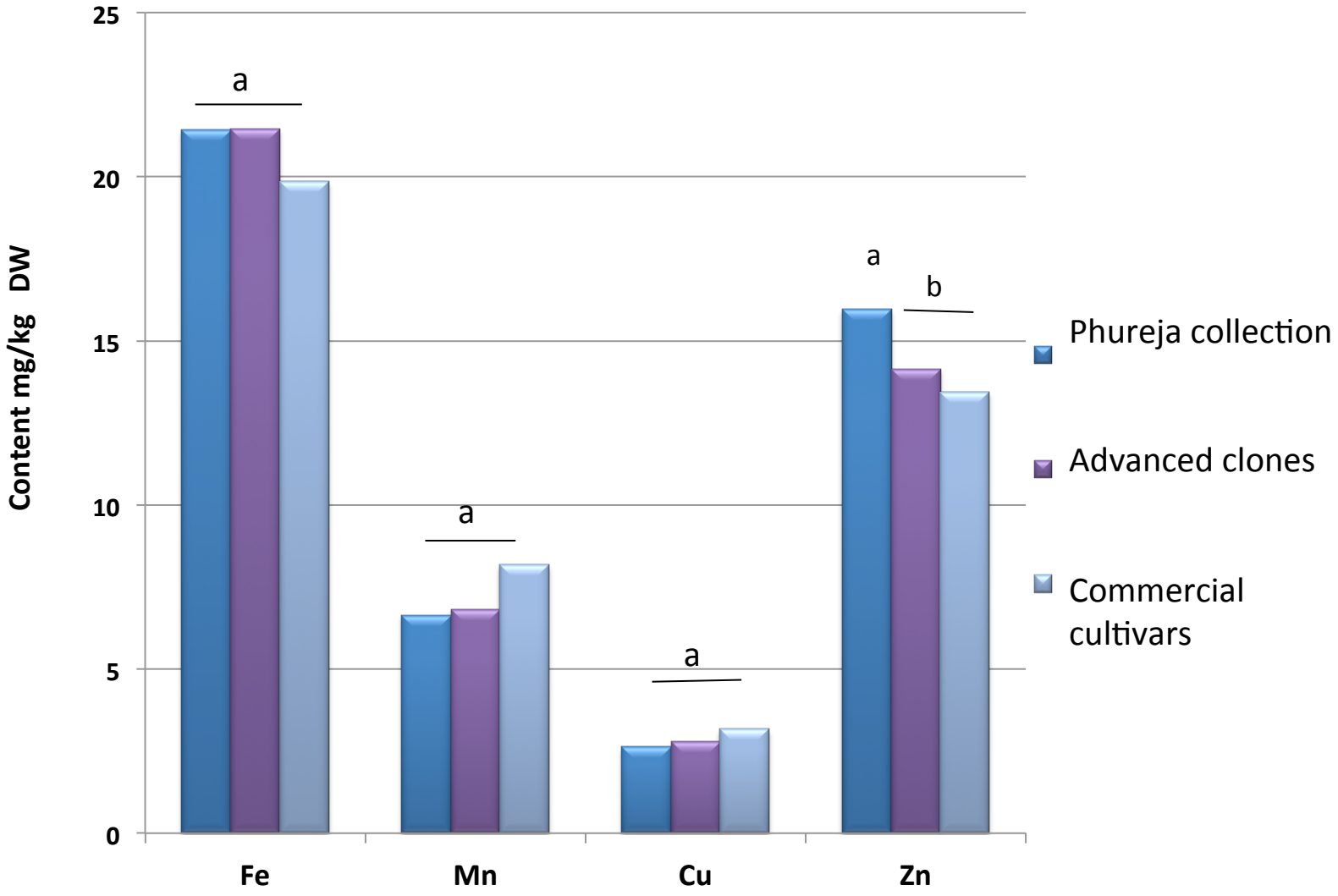
Grind and pulverization

4.2. **Proximal analysis:** Macronutrients content in *Solanum phureja* genotypes

Clara Peña



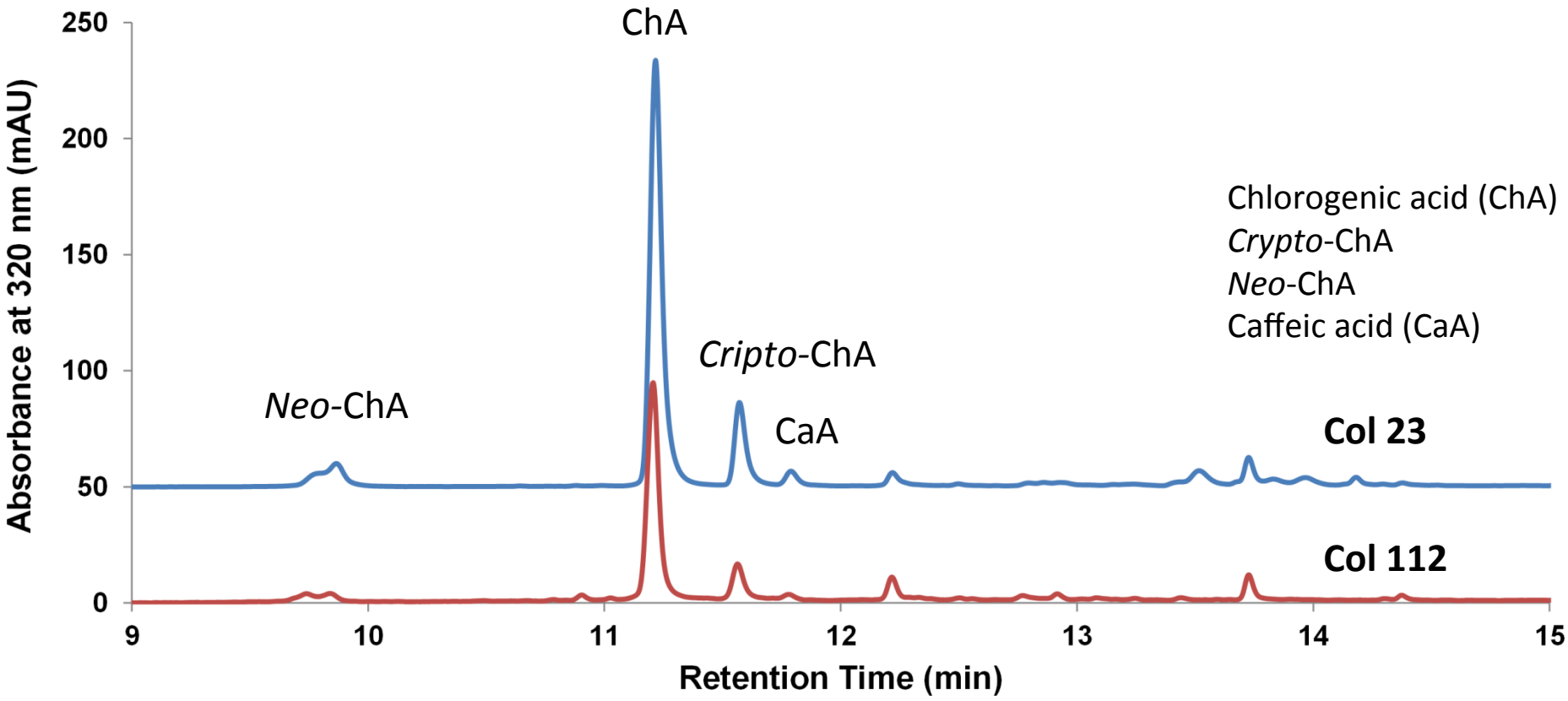
4.2. **Proximal analysis micronutrients:** mineral content in *Solanum phureja* genotypes



Clara Piñeros

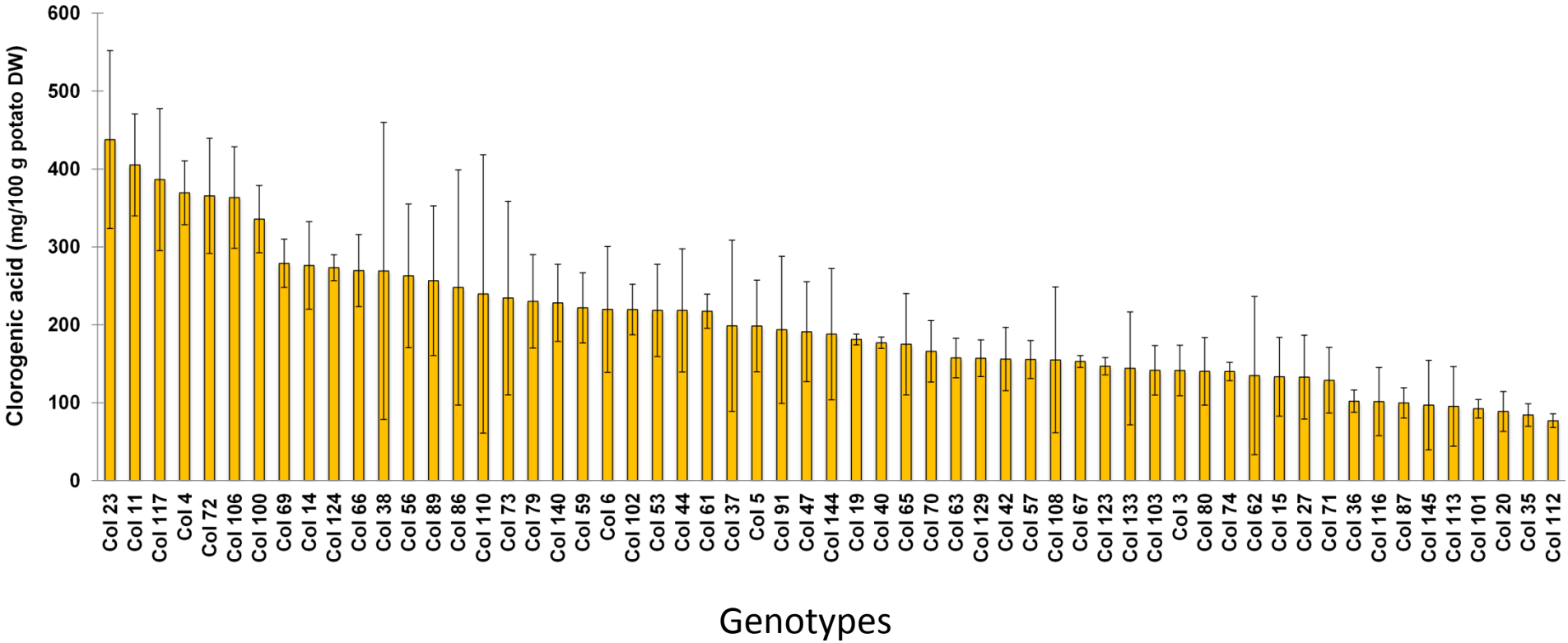
4.3. Phenolic compounds in *Solanum tuberosum* group Phureja

Chromatograms at 320 nm of two potato extracts



Dionex Ultimate 3000 UHPLC system (Thermo Scientific corp) coupled to diode array detector

Chlorogenic acid content in *Solanum tuberosum* group Phureja



4.3. Functional food analysis

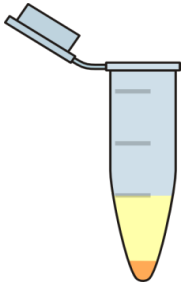

Liyao-Ji Kushalappa A.

Materials and methods

Metabolite extraction & LC-MS analysis

- ✓ **Lyophilized potato flesh**
- ✓ **Eight advanced clones**

ground in liquid N



60% methanol, 0.1% formic acid

Supernatant filtered and injected

LC-ESI-LTQ Orbitrap, Thermo Fisher, Waltham, MA, USA
High resolution hybrid mass spectrometer system

Functional food analysis

Materials and methods

- **Identification and classification of metabolites**
  - ✓ Accurate mass error <5 ppm
  - ✓ MS/MS fragmentation pattern
  - ✓ Classified based on their chemical groups
- **Statistical analysis**
  - ✓ ANOVA will be done to identify significant metabolites.
- **Identification of functional foods**
  - ✓ Metabolites were searched for functional foods properties in the literature.

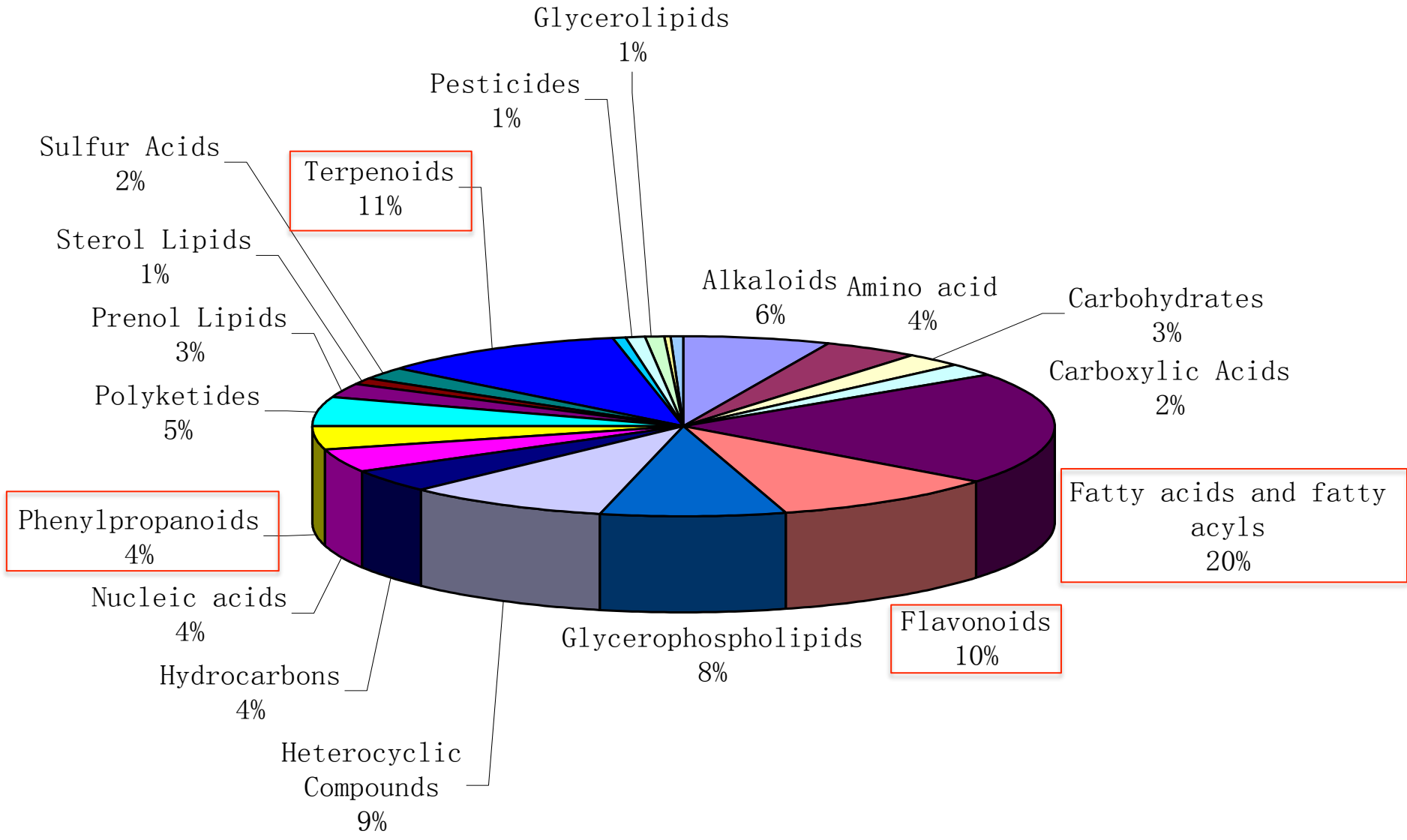
Preliminary results

- 302 metabolites were detected in cooked potatoes in eight genotypes.

- 99 were found to have beneficial roles in human health:
  - ✓ Anti-cancer
  - ✓ Anti-HIV
  - ✓ Anti-hypertension
  - ✓ Anti-inflammatory
  - ✓ Anti-malarial
  - ✓ Antimicrobial
  - ✓ Anti-diabetic

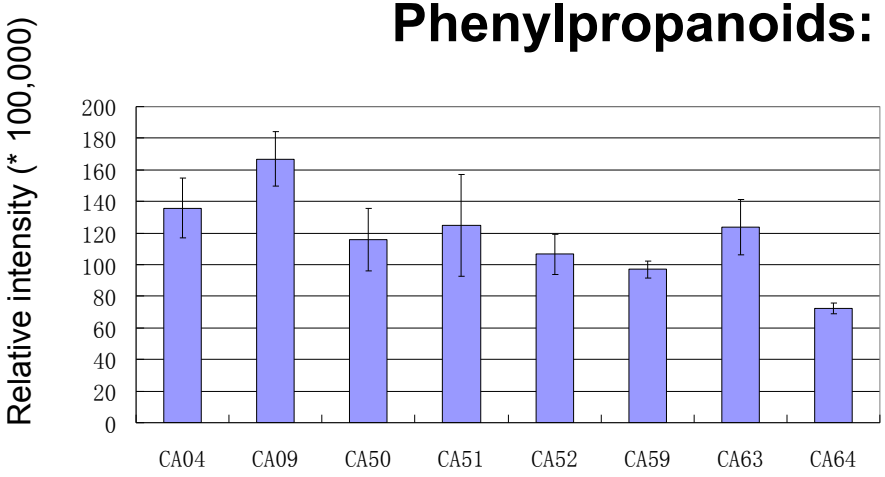
Metabolites chemical groups

Important chemical groups



Relative intensity of some compounds in *S. tuberosum* group Phureja

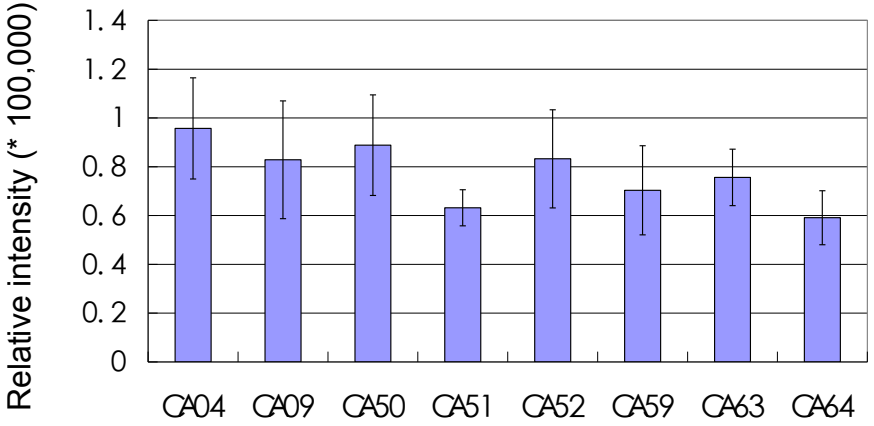
Phenylpropanoids: chlorogenate



Health benefits: antioxiant, anti-diabetic and anti-lipidemic effects.

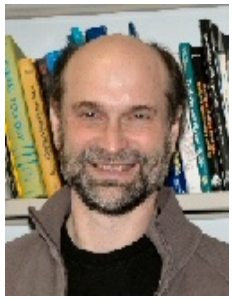
(Bouayed *et al*., 2007; Shafi and Tabassum, 2013)

Flavonoids: Dihydrokaempferol



Health benefits: antimicrobial

(Malterud *et al*., 1985)



Stan Kubow

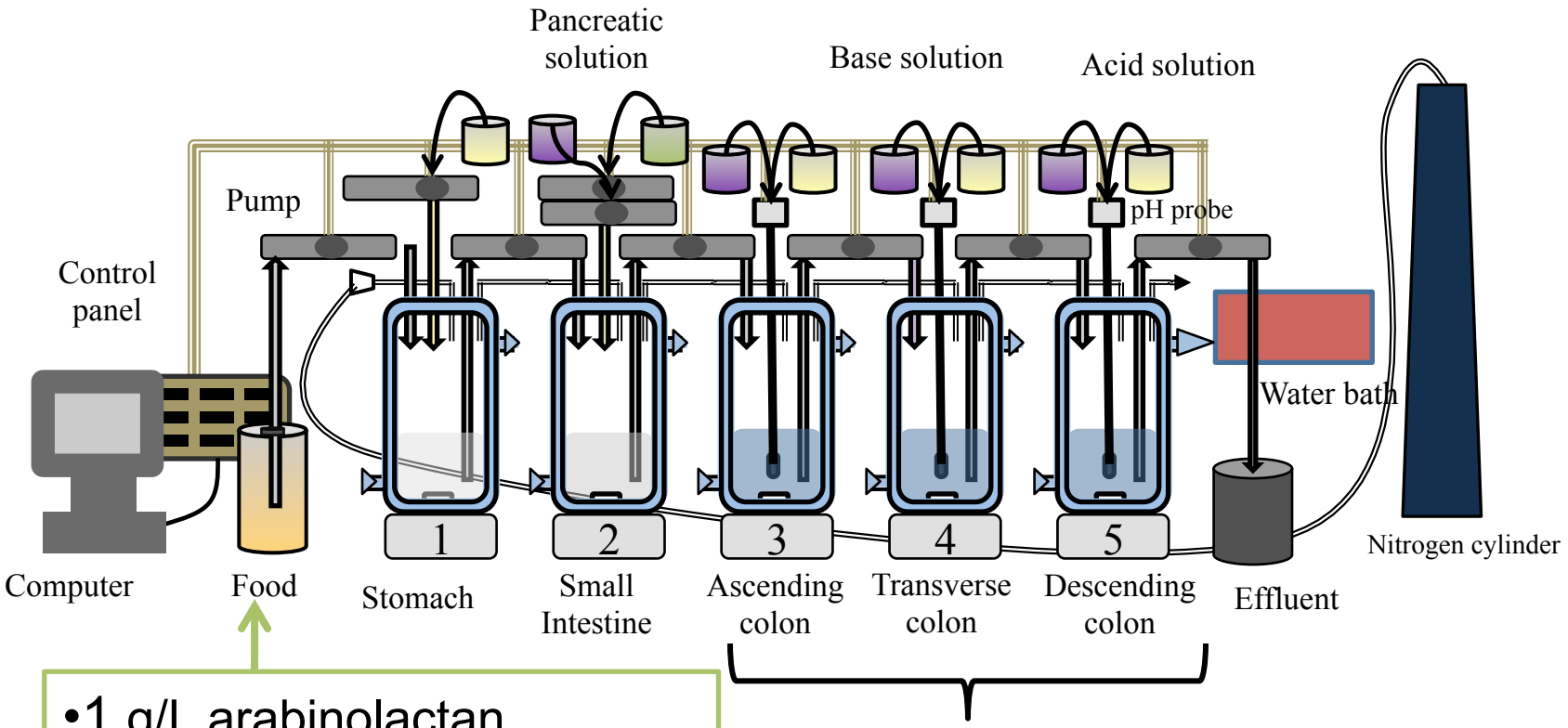
Limitations in identifying the health benefits of polyphenolics

1. Most of the studies are *in vitro* studies.

Pure polyphenolic compound as found in foods.	≠	Variation in polyphenolic structure and absorption in the human gut.

2. Lack of fundamental knowledge regarding bioactive polyphenols formed in the human gut.

Saura-Calixto *et al*., 2007

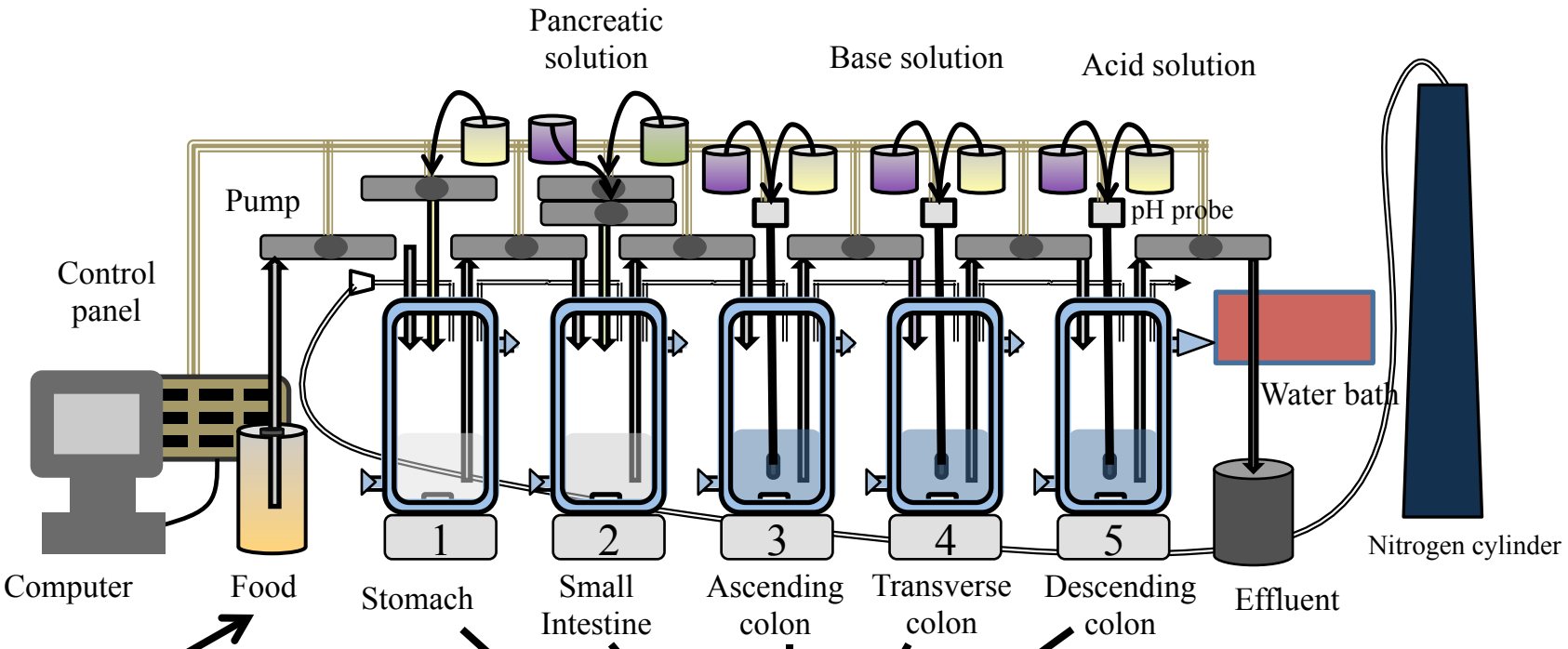


- 1 g/L arabinolactan
- 2 g/L pectin
- 1 g/L xylan
- 3 g/L starch
- 0.4 g/L glucose
- 3 g/L yeast extracts
- 1 g/L peptone
- 4 g/L mucin
- 0.5 g/L cystein powders

GI food

Step 1: Inoculation
Fecal slurry from the fecal samples of five volunteers

Step 2: Stabilization period (two weeks)



GI food +
Treatment /Potato

Sampling

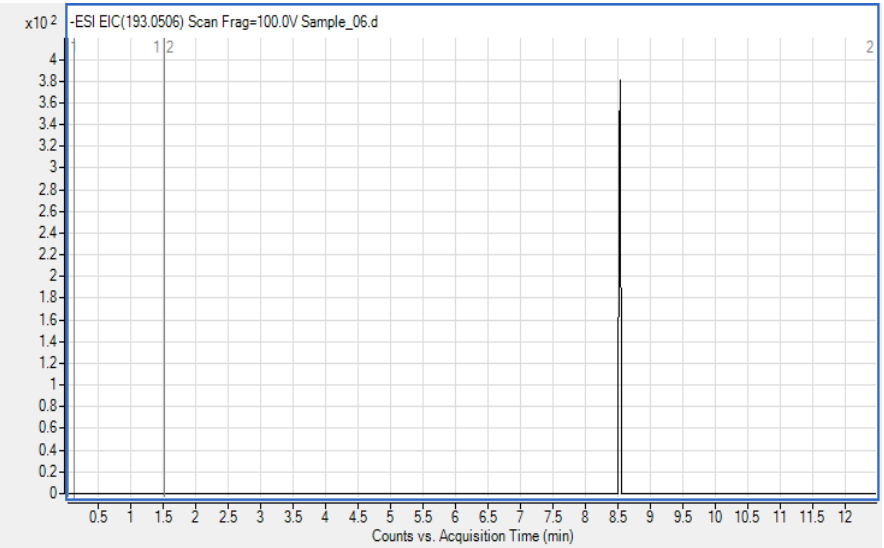
T= 0 hours
T= 8 hours
T= 24 hours

Analyzed by LC-MS TOF
Liquid chromatography coupled to time-of-flight mass spectrometry.

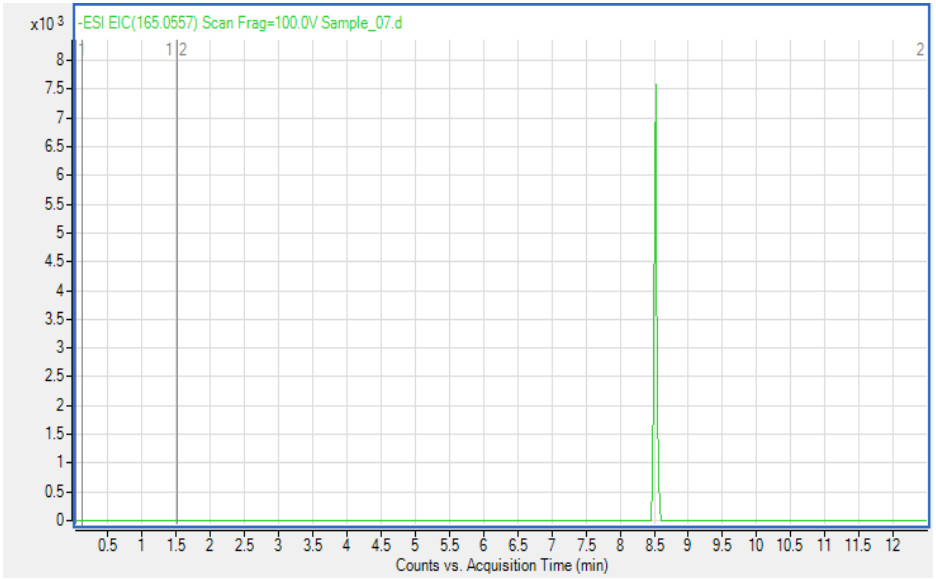
Feeding protocol:
3 times/24 hours

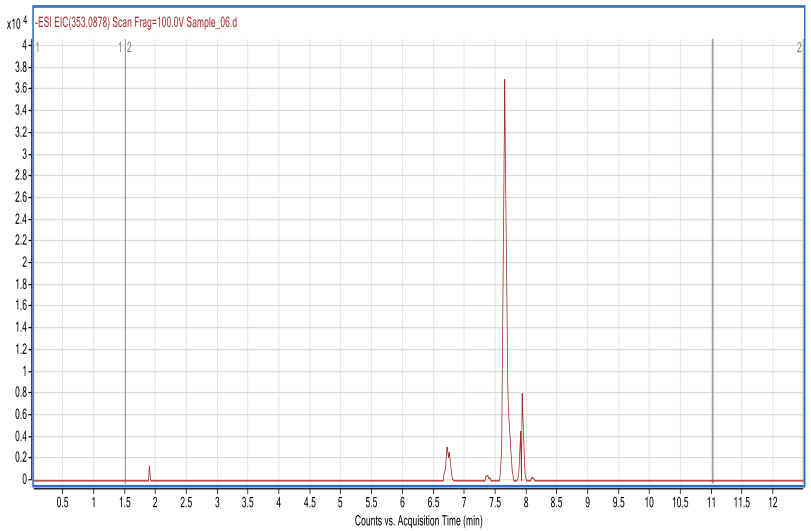
Transformation of ingested polyphenols

Sample taken from the stomach analyzed for ferulic acid- (trace)



Samples from the small intestine analyze for 3-(3-hydroxyphenyl)-propionic acid – (x)





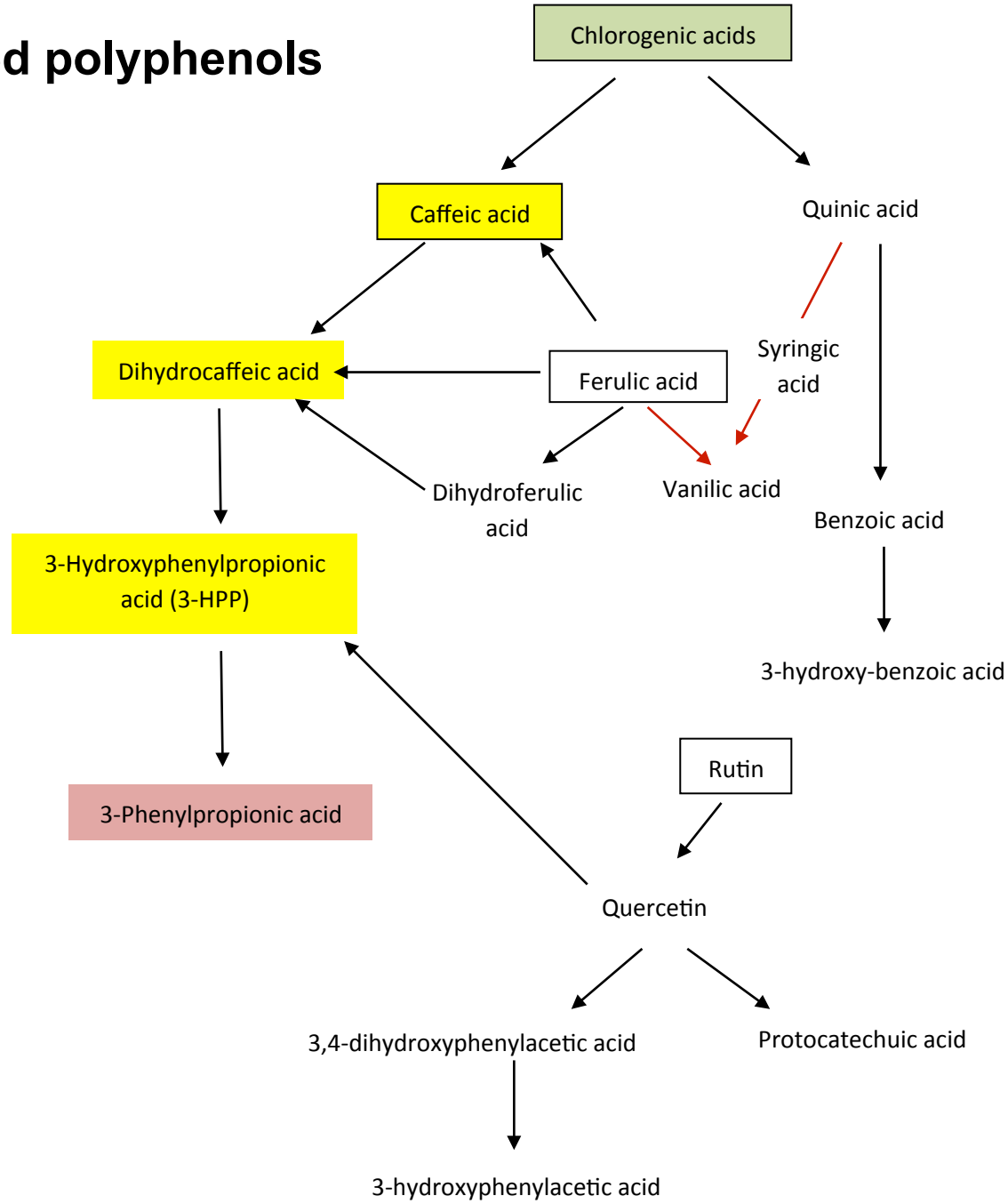
Sample from stomach analyzed for chlorogenic acid- (xx)

Transformation of ingested polyphenols

Chlorogenic acid conversion to 3-phenylpriopionic acid

Colombian Cultivar - 24hr							
Compound	m/z (-ve)	Stomach	Small Intestine	Ascending Colon	Transverse Colon	Descending Colon	Possible metabolic fate
Chlorogenic Acid	353.088	XX	XX	X	TRACE	TRACE	CONVERTED
Neochlorogenic acid	353.088	x	x	xx	x	0	CONVERTED
Cryptochlorogenic acid	353.088	x	x	xx	TRACE	TRACE	CONVERTED
Caffeic acid	179.033	X	XX	XX	XX	X	CONVERTED
3-Hydroxyphenylpropionic acid (3-HPP)	165.056	X	XX	XX	XX	XX	FINAL METABOLITE
3-Hydroxyphenylacetic acid	151.04	TRACE	TRACE	x	xx	xx	FINAL METABOLITE
3-Phenylpropionic acid	149.061	-	-	-	XX	XXX	FINAL METABOLITE

Pathway of ingested polyphenols



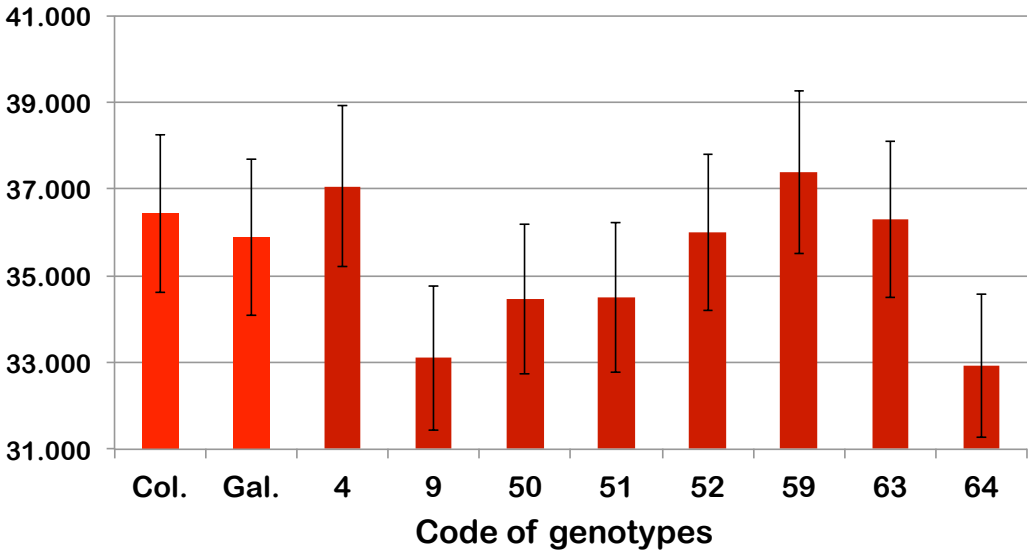
4.4. Moving results to field

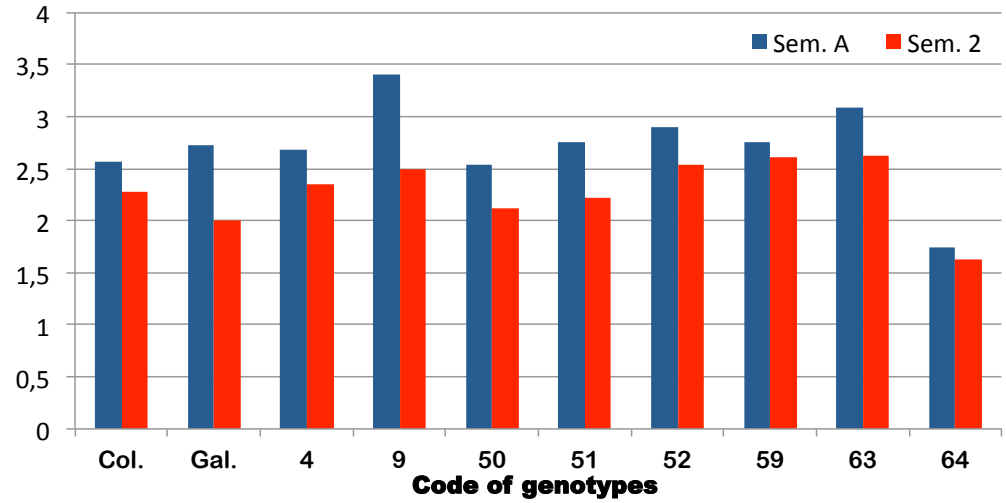
Ernesto Rodríguez

Participative research for selecting new potato cultivars

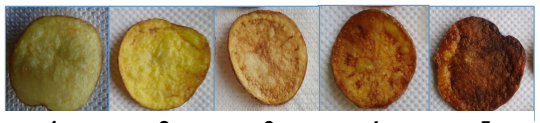
Evaluation was carried out in eight localities during four crop cycles.

Some traits evaluated in advanced potato clones





Scale for the evaluation



New cultivars for linking agriculture to nutrition

Cultivar code 59

Vegetative period: 120 das;
Yield: 37.3 ton/ha,
Dry matter: 23.8;
Frying quality: 2.7

Cultivar code 64

Vegetative period: 120 das;
Yield: 32.9 ton/ha,
Dry matter 25;
Frying quality: 1.7

Cultivar code 4

Vegetative period: 120 das; yield: 37.1 ton/ha, dry matter: 24.7; frying quality: 2.5

das: days after sowing

5. Conclusions and perspectives

- ✓ Variability in the content of macronutrients, micronutrients and functional foods were found in potato. This variability allows making pre-selection and selection of advanced breeding clones for new cultivars.

- ✓ Nutritional quality criteria were introduced in the potato breeding program, in order to strengthen the link agriculture-nutrition-health.

- ✓ To measure the incidence of these new cultivars in iron and zinc assimilation for children under five.

- ✓ To find genetic associations using data from GBS and 2b-RAD.

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Acknowledges

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PROSPERIDAD PARA TODOS

Contract to access genetic resources 53

Foreign Affairs, Trade and Development Canada

Affaires étrangères, Commerce et Développement Canada

IDRC | CRDI

International Development Research Centre

Centre de recherches pour le développement international


Thanks for your attention