

Exploration of underutilized crop diversity of *Capsicum* peppers in their primary center of diversity in Bolivia and Peru

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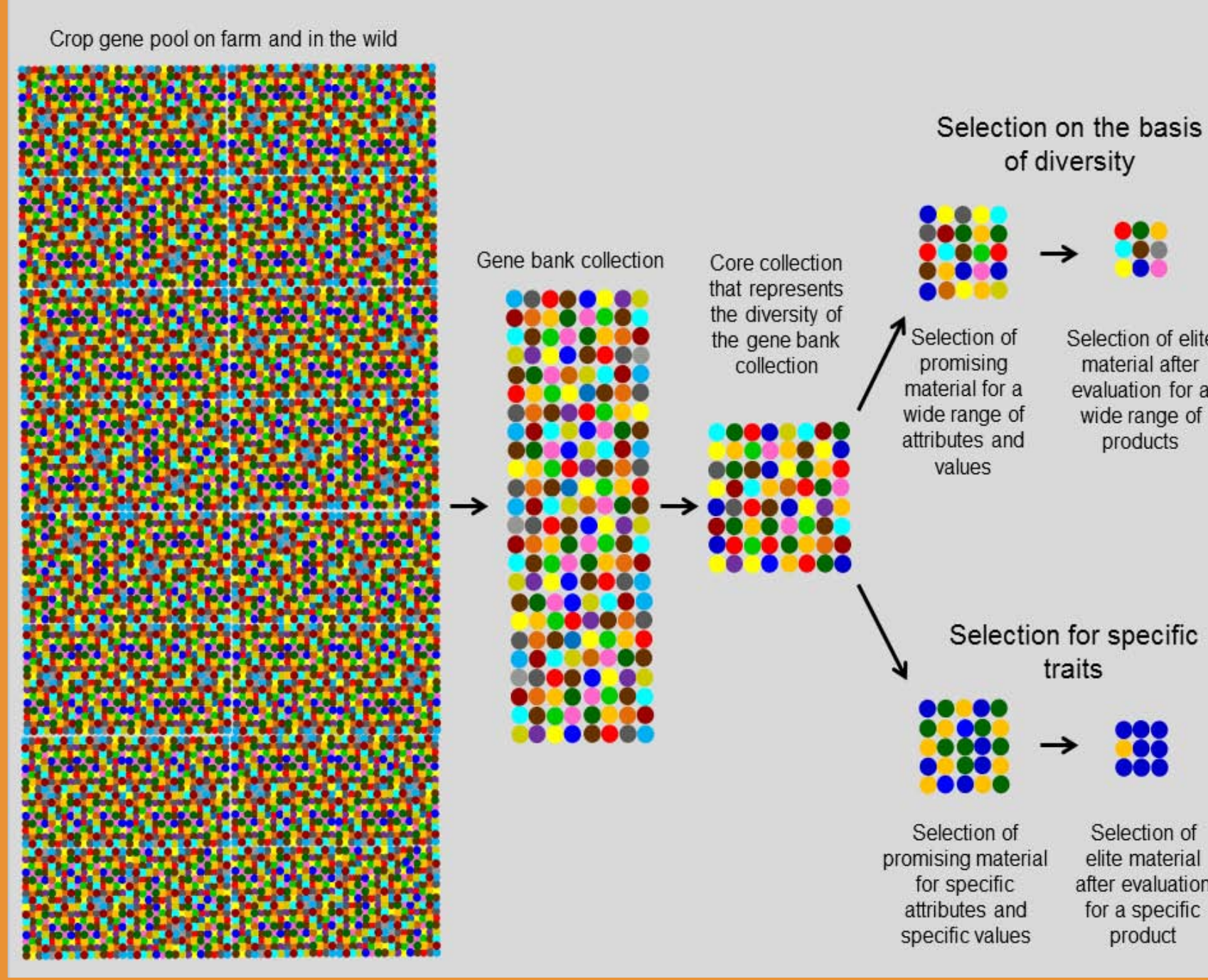
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Capsicum, a highly diverse complex of domesticated & wild species displays abundant variation in its main center of domestication & diversity but remains under-researched



Identification of promising native *Capsicum* germplasm for potential use in the development of differentiated products

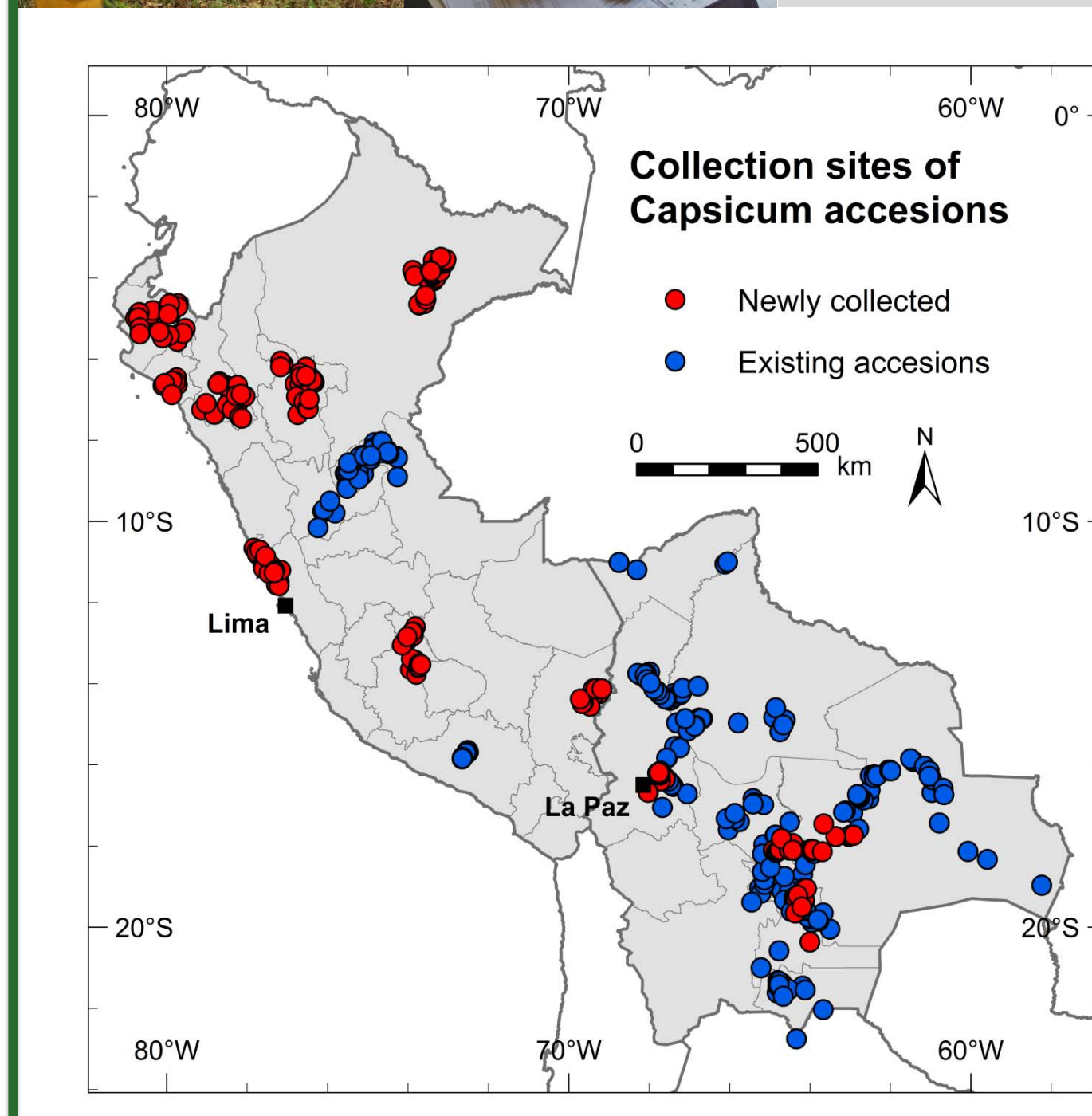
Conceptual model of germplasm conservation and selection (steps 1-4):



1) New collection expeditions: in traditional farming systems, home-gardens & natural vegetation have significantly increased the size of the collections



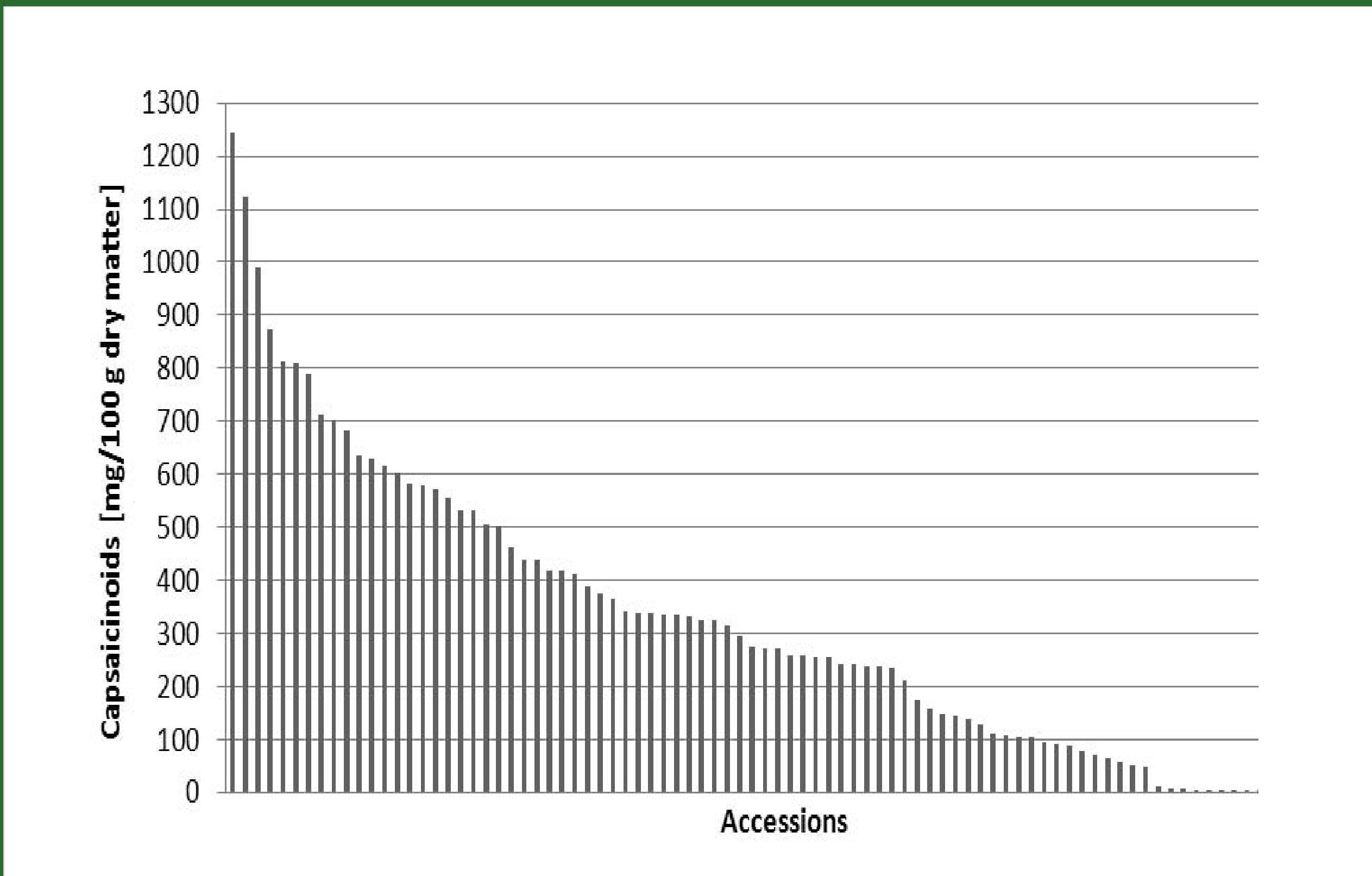
Collection & conservation: INIA-Peru's base collection of 305 accessions increased to 711 including five domesticated species, making it one of the largest and most diverse national collections of native *Capsicum* pepper varieties in the world. CIFP's (Bolivia) base collection of 387 accessions was increased to 466 including five domesticated species, four wild species, and one wild botanical variety of a domesticated species. Taxonomic classification, characterization (agro-morphological, molecular, biochemical) & documentation: Carried out for most accessions.



Taxon	Accessions in CIPF collection (Bolivia)	Bolivian accessions AVRDC*	Bolivian accessions USDA**	Accessions in INIA collection (Peru)	Peruvian accessions AVRDC	Peruvian accessions USDA
Cultivated species						
<i>C. annuum</i> L.	8	9	9	44	37	29
<i>C. baccatum</i> L.	0	45	49	71	95	87
<i>C. baccatum</i> var. <i>pendulum</i> (Willd.) Eshbaugh	217	0	0	0	0	0
<i>C. chinense</i> Jacq.	67	21	26	210	149	120
<i>C. frutescens</i> L.	12	2	4	52	14	5
<i>C. pubescens</i> Ruiz & Pav.	21	0	5	299	5	0
wild species						
<i>C. baccatum</i> var. <i>baccatum</i>	7	0	0	0	0	0
<i>C. caballeri</i> Nee	1	0	0	0	0	0
<i>C. cardenasii</i> Heiser & P. G. Sm.	2	0	1	0	0	0
<i>C. chacoense</i> Hunz.	0	6	9	0	0	0
<i>C. eximium</i> Hunz.	17	0	3	0	0	0
<i>C. flexuosum</i>	0	0	0	0	0	0
<i>C. galapagoense</i>	0	0	0	0	0	0
<i>C. lanceolatum</i>	0	0	0	0	0	0
<i>C. praetermissum</i>	0	0	0	0	0	0
<i>C. rhomboideum</i>	0	0	0	0	0	0
<i>C. schottianum</i>	0	0	0	0	0	0
<i>C. tovarii</i>	0	0	0	0	2	1
Unidentified accessions						
<i>Capsicum</i> spp.	114	4	27	35	19	11

* AVRDC is the acronym of the World Vegetable Center; ** USDA stands for United States Department of Agriculture

2) Identification of a core collection of nearly 100 accessions per country representing the different species and their geographic distribution. Dried samples of these accessions were biochemically screened for 24 commercially interesting attributes, including capsaicinoid content, antioxidant capacity, polyphenols, flavonoids, lipid content and color. The graph below shows the distribution of capsaicinoids -who are responsible for Capsicum's- across accessions of the Peruvian core collection.



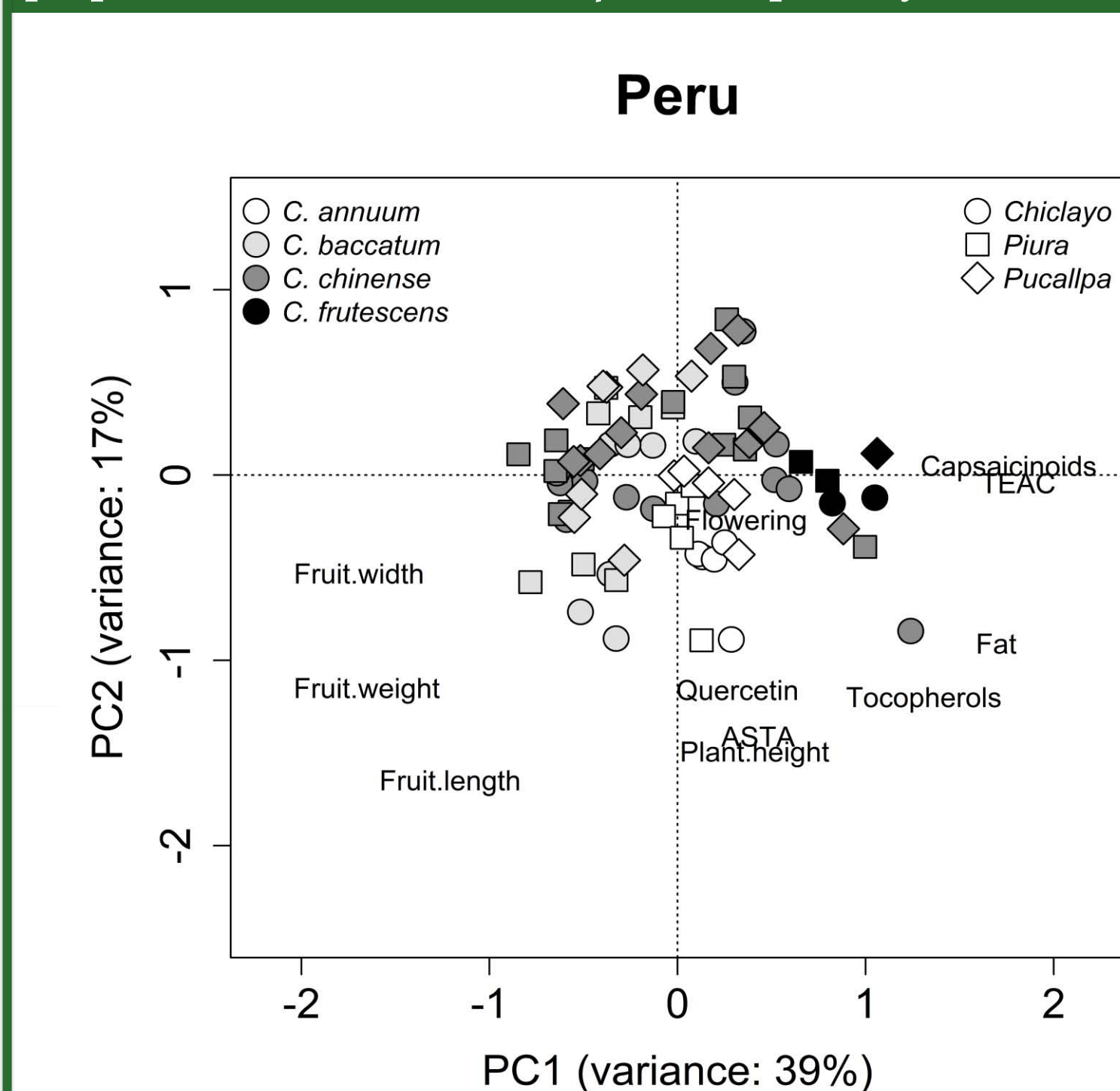
3) Based on the biochemical screening, sub-sets of 44 Bolivian & 39 Peruvian accessions were selected, representing the different species and variation in biochemical attributes

Median values and ranges of biochemical attributes for different accessions in the Bolivian and Peruvian core collections and grouped by taxa.

Taxon	Capsaicinoids (mg/100g)	Antioxidant capacity (mmol/100g)	Polyphenols (g/100g)	Flavonoids (mg/100g)	Quercetin (mg/100g)	Fat (g/100g)	Extractable color (ASTA)
Peru							
<i>C. annuum</i> (n = 19)	335.9 (0.6-809.0)	4.0 (3.1-6.5)	1.77 (1.59-2.07)	8.3 (0.9-29.5)	7.3 (0.9-25.1)	11.1 (2.6-16.6)	75 (5-107)
<i>C. baccatum</i> (n = 26)	204.4 (52.1-711.7)	3.6 (2.8-5.4)	1.72 (1.44-2.59)	7.9 (0.7-27.4)	6.8 (0.7-25.1)	6.2 (2.2-17.1)	24 (1-66)
<i>C. chinense</i> (n = 43)	337.0 (1.2-1244.3)	3.8 (2.1-9.2)	1.75 (1.34-3.69)	4.0 (1.0-14.1)	3.6 (1.0-10.3)	7.6 (2.6-17.1)	31 (4-146)
<i>C. frutescens</i> (n = 2)	789.8 (404.1-1175.4)	5.2 (3.4-7.0)	2.08 (2.07-2.08)	2.3 (1.2-3.4)	2.3 (1.2-3.4)	9.1 (6.2-11.9)	32 (3-60)
Bolivia							
<i>C. annuum</i> (n = 2)	11.7 (11.7-11.7)	3.3 (3.0-3.6)	1.45 (1.37-1.53)	5.0 (4.0-5.9)	3.9 (3.2-4.5)	8.2 (6.7-9.7)	68 (58-77)
<i>C. baccatum</i> var. <i>pendulum</i> (n = 71)	89.9 (0.7-371.7)	4.0 (3.0-5.8)	1.60 (1.18-2.13)	8.6 (1.6-46.8)	7.1 (0.8-42.6)	13.4 (7.6-32.8)	52 (5-127)
<i>C. chinense</i> (n = 7)	181.9 (0.3-311.5)	3.8 (3.1-5.5)	1.43 (1.09-1.74)	3.9 (2.4-4.8)	3.0 (1.6-3.3)	11.8 (7.3-14.2)	55 (8-102)
<i>C. frutescens</i> (n = 4)	427.4 (55.8-1027.9)	4.5 (3.5-6.2)	1.72 (1.54-2.05)	7.5 (4.2-11.0)	5.8 (2.8-9.7)	15.4 (14.8-17.1)	45 (11-69)
<i>C. pubescens</i> (n = 2)	230.4 (223-237.8)	4.4 (4.2-4.5)	1.89 (1.86-1.92)	2.6 (2.3-2.9)	2.2 (2.1-2.3)	7.1 (6.9-7.3)	15 (14-16)
* <i>C. baccatum</i> var. <i>baccatum</i> (n = 7)	334.1 (32.8-438.8)	3.8 (3.6-5.2)	1.43 (1.31-1.63)	7.9 (1.6-12.0)	6.1 (1.6-7.8)	19.4 (11.8-26.1)	23 (3-84)
* <i>C. eximium</i> (n = 3)	417.5 (304.1-454.5)	4.2 (3.9-4.4)	1.92 (1.69-2.19)	4.6 (0.4-6.6)	3.3 (0.4-6.0)	19.4 (18.9-21.4)	26 (12-33)

* Wild species

4) The selected materials were grown in different environments to identify the agro-ecological conditions where they best express the special properties of commercial interest. The biochemical screening and agro-morphological characterization and evaluation revealed that *Capsicum* accessions from Bolivia and Peru have unique combinations of functional attributes, confirming that a wealth of commercially valuable properties can be found in *Capsicum*'s primary center of diversity. Hereunder an Principal Component Analysis (PCA) of the results in Peru.



Catálogo de ajíes (*Capsicum* spp.) peruanos promisorios conservados en el banco de semillas del INIA - Perú

Localidad	Código genético	Volumen E (mg/100g)	Antioxidante (mmol/100g)	Flavonoides (mg/100g)	Quercetina (mg/100g)	Grasa (g/100g)	Color (ASTA)
Chiclayo	1262	30	7.1	11.3	11.3	81	25.1
Piura	1262	21	7.8	11.8	8.8	81	16.8
Pucallpa	1081	30	6.4	9.1	9.1	81	16.1
Piura	1262	23	7.1	9.7	9.7	81	15.7
Perú	11	19	10	13	13	84	22.5

In Bolivia, wild peppers, locally known as "arivivi" and "ulupica", have a high market potential. Mexican experts came to Bolivia to train local agronomists and farmers in sustainable extraction of wild peppers and how to cultivate and domesticate them.

Catálogo de ajíes (*Capsicum* spp.) bolivianos promisorios conservados en el banco de semillas del INIAF - Bolivia

Código Nacional: 361	Especie: <i>Capsicum baccatum</i> L. var. <i>baccatum</i>
Sitio de origen: Departamento Santa Cruz, Provincia Costanera, Localidad Camati	
Habitat de crecimiento: Interoceánica (compacta)	
Producción: 0.5 kg/planta	
Rango de selección: 0.007-0.44kg/planta	
Peso del fruto: 1.1 g	

Caracterización bioquímica del fruto seco (valor y rango de selección):

Capsaicinoides (mg/100g)	Volumen E (mg/100g)	Antioxidante (mmol/100g)	Flavonoides (mg/100g)	Quercetina (mg/100g)	Grasa (g/100g)	Color (ASTA)
286	153	3.9	11.2	10.8	80	28.2
0.6-1.0278	4.3-44.87	3.38-6.24	1.77-62.7	1.47-99.2	149-344	70-243

Nota: Provenido de Santa Cruz y Patilla