Agro-biodiversity of apricot landraces in Gilgit-Baltistan (Pakistan) using morphological and genetic traits

Iftikhar Alam[1*], Martin Wiehle[1-2], Arslan Nawaz[1], Annette Braun-Lüllemann[4], Oliver Gailing[3], Markus Mueller[3], Andreas Buerkert[1]

[1] Organic Plant Production and Agroecosystems Research in the Tropics and Subtropics (OPATS), University of Kassel, Steinstrasse 19, D-37213 Witzenhausen, Germany
[2] Center for International Rural Development (Tropenzentrum), University of Kassel, Steinstrasse 19, D-37213, Witzenhausen, Germany
[3] Forest Genetics and Forest Tree Breeding, Georg-August University of Göttingen, Büsgenweg 2, D-37077, Göttingen, Germany
[4] Pomologenverein, An der Kirche 5, D-37318 Hohengandern, Germany

Introduction & Methods

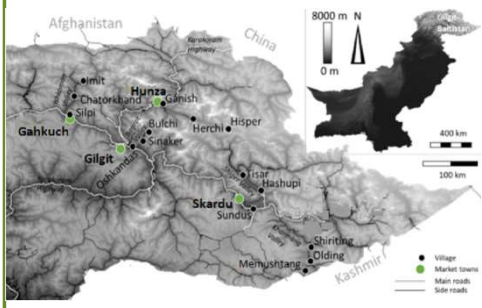

Fig. 1. Map of studied villages used for the collection of local apricot varieties in five valleys of Gilgit-Baltistan, northern Pakistan in 2021. (Sources: DICA-GIS, www.diva-gis.org/gdata, accessed 10th November 2022)

Apricot (*Prunus armeniaca* L.), Rosaceae, is widely spread across temperate climates of the northern hemisphere, including the autonomous Gilgit-Baltistan (GB) region in northern Pakistan (Fig. 1). According to ancient stories, apricots were used for centuries as a staple food in this area. Their high nutritional and medical value is still appreciated by indigenous people of the region. Many local landraces of apricot are available although some of them became rare and are at risk of extinction, because modern varieties push back local landraces as result of market preferences. Therefore, morphological (dendrometric and fruit traits) and genetic data (microsatellite markers) of 240 trees from five valleys and three villages (high, medium and low altitude) each were assessed to identify the available richness and diversity, to assign their genetic relation (synonymy/homonymy), and to develop suitable *ex* and/or *in situ* conservation strategies for this important staple crop of the region.

Results & Discussion

Landrace richness and diversity: Based on morphological parameters, 122 out of 240 landraces were synonyms according to the names provided by farmers, resulting in a significant variation of α-diversity within regions, valleys, and villages (Figure 2). Four main distinct clusters were found based on the landrace differences across villages (β-diversity, Figure 3).

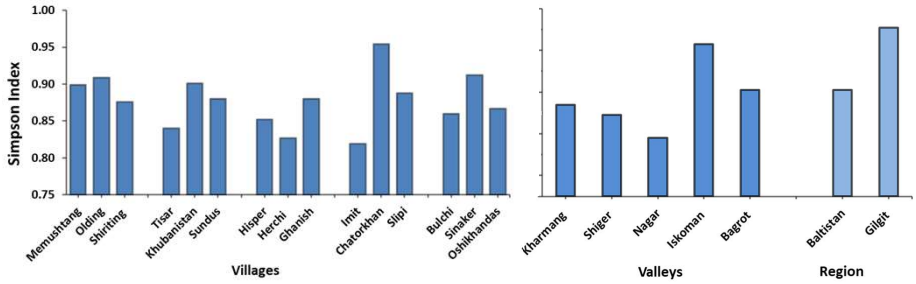

Figure 2. Relative abundance and contribution of each apricot landrace/variety (n = 240) to overall α-diversity among villages, valleys, and regions of Gilgit-Baltistan, Pakistan, surveyed between July and October 2021

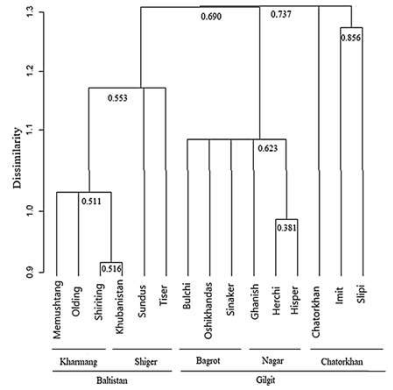

Figure 3: Dendrogram with contiguity constraint abundance values based on chord distance from 15 villages of 5 valleys of Gilgit-Baltistan, Pakistan. β-diversity values are given in each node; total average weighted beta is 0.737.

Genetic variation among regions, valleys, and villages:

Region and valley-wise, genetic diversity parameters were highest for the Gilgit region as well as the Ishkoman and Bagrot valley. Low-altitude villages in the Kharmang and Shiger valleys of the Baltistan region tended to exhibit high richness and diversity values, while the valleys of the Gilgit region, Nagar, Ishkoman, and Bagrot, showed an opposite trend (Table 1). AMOVA revealed high genetic variation within groups (range: 96% to 97%). Overall F-statistics showed a low fixation level, however, F-values (F_{ST}, F_{IS}, F_{IT}) increased numerically from the regional to the village level.

The most abundant landraces were Shikanda, Halman, Shakanda, Habi, Ali Shah Kakas, Marghulam, Boto Shakanda, Meli, and Longpo, which was also congruent with genetic data, indicating putatively true-to-type landraces. Typus-varieties from local genebanks, Gold Rich and Pisana, used as reference material, confirmed the reliability of our SSR markers. In total n = 39 (16.4%) landraces were assigned as true-to-type.

Table 1. Genetic variation and differentiation in apricot landraces from 15 villages within 5 different valleys of Gilgit-Baltistan, Pakistan,(July-October 2021).

Sites of sampling		Na	Na freq. ≥ 5%	Ne	I	No. private alleles	He	uHe	F_{IS}
Villages	Memushtang	5.33	3.92	3.33	1.32	0.00	0.66	0.69	-0.144
	Olding	5.67	3.75	3.40	1.35	0.00	0.66	0.69	-0.172
	Shiriting	5.50	3.83	**3.62**	**1.40**	0.00	**0.69**	**0.73**	**-0.060**
	Tiser	4.25	4.25	2.99	1.16	0.00	0.61	0.65	-0.232
	Khubanistan	5.25	4.33	3.18	1.27	0.08	0.64	0.66	–0.67
	Sundus	5.58	3.92	**3.39**	**1.34**	0.17	**0.67**	**0.69**	**-0.125**
	Hisper	5.50	4.25	**3.82**	**1.44**	0.00	**0.72**	**0.75**	**-0.150**
	Herchi	5.42	4.25	3.47	1.37	0.00	0.70	0.72	-0.125
	Ganish	4.83	3.58	2.92	1.22	0.08	0.64	0.66	-0.197
	Imit	6.17	4.42	**3.97**	**1.50**	0.08	**0.71**	**0.74**	**-0.003**
	Chatorkhan	6.92	4.25	3.68	1.44	0.08	0.68	0.69	-0.002
	Slipi	6.17	5.08	3.96	1.50	0.08	0.70	0.73	0.080
	Bulchi	5.25	5.25	**3.62**	**1.37**	0.17	**0.69**	**0.73**	**-0.163**
	Sinaker	6.08	3.75	3.45	1.35	0.08	0.69	0.70	-0.171
	Oshikhandas	4.83	3.67	3.32	1.29	0.00	0.68	0.71	-0.145
Genebanks	Skardu_R	3.83	3.83	3.27	1.22	0.00	0.66	**0.79**	**-0.298**
	Jaglot_R	7.58	5.42	**4.39**	**1.62**	0.00	**0.73**	0.75	-0.030
Valley	Kharmang	7.00	4.33	3.63	1.45	0.00	0.69	0.70	-0.097
	Shiger	6.83	4.25	3.42	1.39	0.33	0.67	0.68	-0.072
	Nagar	6.83	3.83	3.52	1.43	0.08	0.70	0.71	-0.128
	Ishkoman	8.25	5.08	**4.14**	**1.57**	0.42	**0.71**	**0.72**	**0.045**
	Bagrot	7.17	3.92	3.64	1.43	0.33	0.70	0.71	-0.133
Regions	Baltistan	9.33	4.50	3.80	1.55	0.33	0.70	0.70	-0.061
	Gilgit	10.50	4.50	**4.15**	**1.62**	**1.50**	**0.73**	**0.74**	**-0.016**

Conclusions

Across the five valleys, we confirmed a very diverse phenotypic characterisation from this study which may serve as an essential prerequisite for the effective and efficient utilization of the available germplasm in future apricot breeding and conservation programs.