Bróquil (*Brassica oleracea* var. *italica*) landraces in the Aragón region (Northeastern Spain)

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Bróquil is a traditional winter cole crop typical in the Northeast of Spain, mainly in Huesca province. It is locally produced for its organoleptic traits, with a peculiar taste. It is grown in family orchards for auto-consumption, but also in small farms for local markets. Bróquil edible parts are a mix of young leaves and inflorescences or heads. Plants show many axillary sprouts formed by a group of leaves with a central inflorescence of variable size.

Under the name of bróquil, two different types of plants are cultivated by farmers in our region: the 'green bróquil' type (locally known as 'bróquil verde') and the 'headed bróquil' type (or 'bróquil pellado'). Figure 1 shows an example of both typologies. Many sprouts, born from axillary buds of older leaves, form the green bróquil plants. A group of young leaves surrounding a small curd ,when the floral stage arrives, forms each sprout. Nevertheless, curd size is bigger in headed bróquil type and curds predominate over leaves. Color heads are yellow, from pale to yellow green. It seems that both bróquil types are ontogenetically younger than broccoli inflorescences, remembering cauliflower. Marketable maturity arrives when curds start to appear and form together with the leaves, a compact plant structure.

Taxonomy

Bróquil belongs to Brassicaceae family, previously known as Cruciferae, specifically to the *Brassica oleracea* L. species. *B. oleracea* L. is an important species that probably originated in the eastern Mediterranean area (Babula et al. 2007), although this point is controversial. From the East, it dispersed towards the North and the South of Europe originating a heterogeneous group, considering both morphological characters and culinary uses. As Ciancaleoni et al. (2014) pointed out, the extreme plasticity of the species, the possibility of wide crossing with many other species belonging to the same genus, as well as to Brassica-related genera and human selection during domestication have differentiated a large number of cultivated forms. In that way, the species include cabbage, broccoli, cauliflower, kale, brussels sprouts, collard greens, savoy or kohlrabi, in addition to several traditional forms locally known, as bróquil, and also all the oriental forms not common in our continent.

Taxonomically, each *B. oleracea* form belongs to a specific botanical group. In the absence of more detailed studies, bróquil belongs to *B. oleracea* L. italica group whose main member is broccoli. According to the main hypothesis, this group evolved from wild progenitors in the eastern part of the Mediterranean (Harberd 1976), where the first crops were probably domesticated, although others also suggest southern Italy as the domestication area (Maggioni et al. 2010).

A wide range of sprouting coloured headed broccolis exist in southern Italy, Sicily and small Italian islands, which would indicate this area as the main centre of diversity. Many different landraces are cultivated in both large fields and home gardens and are highly appreciated for their organoleptic traits by local people (Branca 2008). Gray (1993) summarized several forms of Italic group grown for fresh markets in that area. It includes purple sprouting broccoli, purple cape broccoli, white sprouting broccoli, purple Sicilian broccoli, calabrese or black broccoli. Calabrese type originates the actually worldwide known broccoli. White sprouting broccoli is described as 'overwintering, branched, white spears. Distinct early and late maturing forms of which the late type more strictly within the Botrytis group'. This description fits bróquil morphology, although general appearance of the plants and the spears development in bróquil looks different from white sprouting broccoli. Probably commercial relations between territories of historical Aragón kingdom contributed to the arrival of white sprouting broccoli seeds to actual Spanish territories, where the species continued to evolve.

Agronomic practices

Bróquil production involves traditional agronomic practices common to other cole crops such as cabbage, cauliflower or broccoli, usually cultivated at the same orchards. Bróquil is a cool-season vegetable. Seeds are sown in 200 cell plug trays, and young plants are then transplanted into the open field. The sowing season begins in the last week of June and is continuous up to August in order to transplant the young plants from the last week of July to the first week of September. It is a rustic plant well adapted to different type of soils. Land is prepared by ploughing. Previously, cow or sheep organic manures should be spread in the field. Then, the land should be levelled and conditioned before transplanting. Fertilisation rates follow other *B. oleracea* vegetable crop recommendations. Mineral fertiliser applications are usually split into pre-plant and one post-plant application. Total nutrient amounts depend on the soil properties, manure input, or previous crop species. Cropping area pH is commonly alkaline. A ridges and furrow type of layout is used for the crop. Typical plant spacing is single row with 60-80cm between rows and 45-70cm between plants in the row.

The most common irrigation system is by surface flooding, although drip irrigation is also frequent where technology is in place. Irrigation at the time of transplanting is essential. A steady supply of moisture is necessary for good growth and development. The interval between two irrigations depends upon climate, soil, plant growth and seasonal rainfall. In dry fall seasons, irrigation at an interval of 10-15 days is enough.

Many diseases and insects common to other cole crops also attack bróquil. The most common bróquil pest in the traditional growing area of Huesca are caterpillars, aphids, and whitefly. Lepidoptera cause very important damage. *Pieris rapae* and *Pieris brassicae* caterpillars devour leaves in only a few days. Also *Mamestra brassicae* and *Plutella xilostella* could attack the crop. Aphids as *Brevicoryne brassicae* and the Hemiptera *Aleyrodes proletella* may infest plants and spoil productions. Farmers tend to use conventional authorised chemicals to control pests, but biological products such as *Bacillus thuringiensis*, insecticidal soap, or pyrethrum are also frequently applied. Diseases are not important for this crop, although *Sclerotinia sclerotiorum* may sporadically affect some plants.

Bróquil cultivation takes place mainly on family orchards for on-farm consumption and only a few farmers produce for local markets. Bróquil harvesting is carried out dependent on the maturity of the sprouts. Plant material sow differences in days-to-harvest ranged from 190 to 220 days in our region. The green bróquil cycle is shorter than for headed bróquil, although this fact is dependent of plant material genetic properties. This vegetable is related to Christmas-time because is at that moment when first plants reach the local markets. Harvesting period prolongs to February. Increasing day-length induces flowering and then heads extend, harden, and depreciates production. Farmers cut the whole plant that achieves an average weight of four kilos at commercial maturity. External leaves are eliminated before they are sent to the market and only 10% of plant weight will be the raw ingredient to cook. No data of yield per hectare is known.

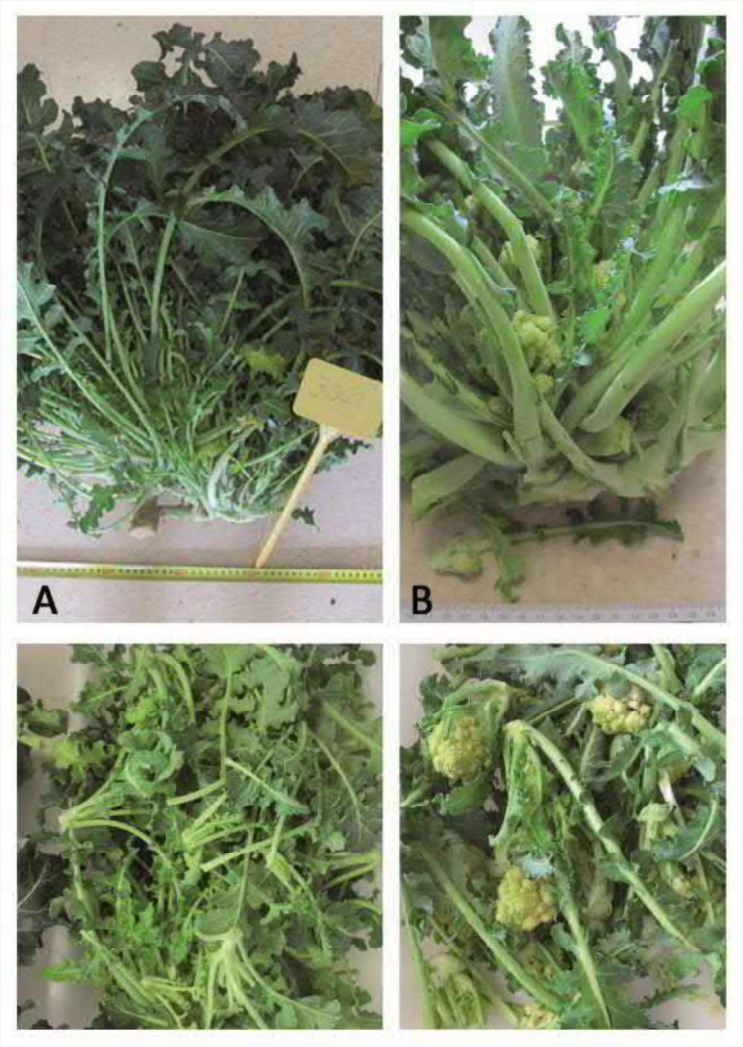

Figure 1. Bróquil landrace types. A: green bróquil and B: Headed bróquil.

Plant material and biodiversity

Nowadays, cultivated bróquil plant material comes from two nurseries located in Huesca, the capital of the province (Figure 2). Both nurseries produce only five varieties of seedlings, two green bróquil and three headed bróquil. Nursery owners multiply and maintain their own varieties year by year. Bearing in mind the *B. oleracea* open pollination behavior, this task has a big risk of losing landrace identity. In order to avoid crosspollination between different landraces or other brassica groups, nursery farmers multiply only one of them by year and they produce it in remote farms. No commercial bred material exists.

These landraces are kept in the Spanish vegetable genebank of Zaragoza (BGHZ in Spanish) where seeds are maintained in dryers and freezers. BGHZ was founded in 1981 and holds a collection of 17,425 accessions belonging to more than 300 vegetable species, mainly of Spanish landraces or farmers' varieties, but also crop wild relatives and neglected and underutilised species. Information about stored accessions is available in the Spanish National Inventory and EURISCO databases (FAO code: ESP027).

Figure 2. Local producers in Huesca. A: Oliván nursery; B: Barbereta nursery; C: Bróquil field; D: Marketing their own produce.

Table 1. Bróquil accessions stored in the Vegetable Genebank of CITA (BGHZ-CITA) in Spain (FAO code ESP027).

Genebank code	Bróquil landrace type	Origin		
		Locality	Province	Country
BGHZ2636	Headed / pellado	Huesca	Huesca	Spain
BGHZ2637	Headed / pellado	Huesca	Huesca	Spain
BGHZ2638	Green / *verde*	Huesca	Huesca	Spain
BGHZ3021	Green / *verde*	Barbastro	Huesca	Spain
BGHZ4057	Green / *verde*	Calatayud	Zaragoza	Spain
BGHZ6685	Headed / *pellado*	Binéfar	Huesca	Spain
BGHZ6686	Green / *verde*	Azlor	Huesca	Spain
BGHZ6687	Headed / *pellado*	Ayera	Huesca	Spain
BGHZ6688	Green / *verde*	Barbastro	Huesca	Spain
3,975	Headed / *pellado*	Barbastro	Huesca	Spain
4,548	Headed / *pellado*	Barbastro	Huesca	Spain
4,678	Headed / *pellado*	Huesca	Huesca	Spain
5,007	Headed / *pellado*	Huesca	Huesca	Spain
5,008	Green / *verde*	Huesca	Huesca	Spain
HU004	Green / *verde*	Ayera	Huesca	Spain
HU009	Green / *verde*	Arbaniés	Huesca	Spain
HU028	Headed / *pellado*	San Juan de Plan	Huesca	Spain

This genebank preserves a collection of 17 accessions of bróquil, mainly from Huesca province (Table 1). These accessions are being studied considering both agronomic and quality characteristics, in order to select for specific desirable traits to develop improved varieties of bróquil (Montaner et al. 2018) (Figure 3).

Ethnobotany of bróquil

Bróquil was deep-rooted in popular gastronomy, being usually grown during the 50th years in a lot of local orchards for self-consumption (Figure 4). The slaughtering of the pig used to take place at the same time as bróquil harvest dates, so it was very common to consume pig meat together with bróquil. In the 1960s, the first hybrid cauliflowers arrived, with different growing cycles, covering longer periods of time. In the 1980s, they started to grow broccoli, later romanescu, and recently bimi and kale.

These new varieties were very well accepted by farmers for their productivity, culinary characteristics, easy handling in the kitchen, taste, good acceptance by young people. All these factors had a share in displacing bróquil landraces as the predominant winter vegetable in the local area.

Figure 3. Experimental assay of bróquil. A and B: shaded house; B and C: field; D and E: sampling and laboratory analysis.

Figure 4. Traditional food preparation of bróquil with potato (A, B and C).

Today broquil is only grown by a few elderly local growers, who have grown bróquil since the dawn of time and know its excellent properties.

A local project has recently been initiated in order to promote bróquil among the people that no longer know this product, although it was very well known in the not too distant past.

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References

Babula D, Kaczmarek M, Ziółkowski P, Sadowski J (2007) *Brassica oleracea*. In: Kole C (eds.) Genome mapping and molecular breeding, Vol 5: Vegetables. Springer, Heidelberg, Berlin, New York, Tokyo, pp 227–285

Branca F (2008) Cauliflower and broccoli. In: Prohens. J. & Nuez, F. (eds) Vegetables I. Springer, New York, pp 147–182

Ciancaleoni S, Chiarenza GL, Raggi L, Branca F, Negri V (2014) Diversity characterisation of broccoli (*Brassica oleracea* L. var. *italica* Plenck) landraces for their on-farm (*in situ*) safeguard and use in breeding programs. Genetic Resources and Crop Evolution 61:451–464

Gray AR (1993) Broccoli, *Brassica oleracea* L. (*italica* group). In: Kalloo G. & Bergh, B.O. (eds) Genetic improvement of vegetable crops. Elsevier Ltd. pp 61-86

Harberd DJ (1976) Cytotaxonomic studies of Brassica and related genera. In: Vaughan J.G. (ed) The biology and chemistry of the cruciferae. Academic Press, London, AJ McLeod and BMG. Jones, pp 47–68

Maggioni L, von Bothmer R, Poulsen G, Branca F (2010) Origin and domestication of cole crops (*Brassica oleracea* L.): linguistic and literary considerations. Economy Botany 64:109–123

Montaner C, Zufiaurre R, Mallor C (2018) Caracterización morfológica y evaluación productiva de 11 entradas de bróquil conservadas en el Banco de Germoplasma Hortícola de Zaragoza. Actas de Horticultura 80: 30-33