PLANT PRODUCTS FROM THE HIGH ATLAS

A catalog of some of the most important species for local livelihoods and the region's biodiversity.

Publication by the Moroccan Biodiversity & Livelihoods Association
Supported by MAVA Foundation for Nature

Cover design by Ibtissam Bouseta

Plant products from the High Atlas

***1. Thymus satureioides* L.**

Name in Amazigh:	Tazouknit
Name in English:	Thyme
Used parts:	Leaves and flowers
Examples of use:	condiment, infusion, incense, aromatherapy.
Fun Fact:	Thyme is used to add a zesty flavour to Lben (Moroccan buttermilk)

***2. Ceratonia siliqua* L.**

Name in Amazigh:	Tikida
Name in English:	Carob
Used parts:	Fruits, leaves, tank.
Examples of use:	Cattle feed, cosmetics, pharmaceuticals & food Carob does not contain caffeine and theobromine.

***3. Juglans regia* L.**

Name in Amazigh:	Aswik, Douj
Name in English:	Walnut tree
Used parts:	Fruits, leaves, barks
Examples of use:	Food, cosmetics, pharmaceuticals, natural dye.
Fun Fact:	Some walnut tree's potential lifespan can reach 400 years.

***4. Prunus dulcis* (Mill.) D.A.Webb**

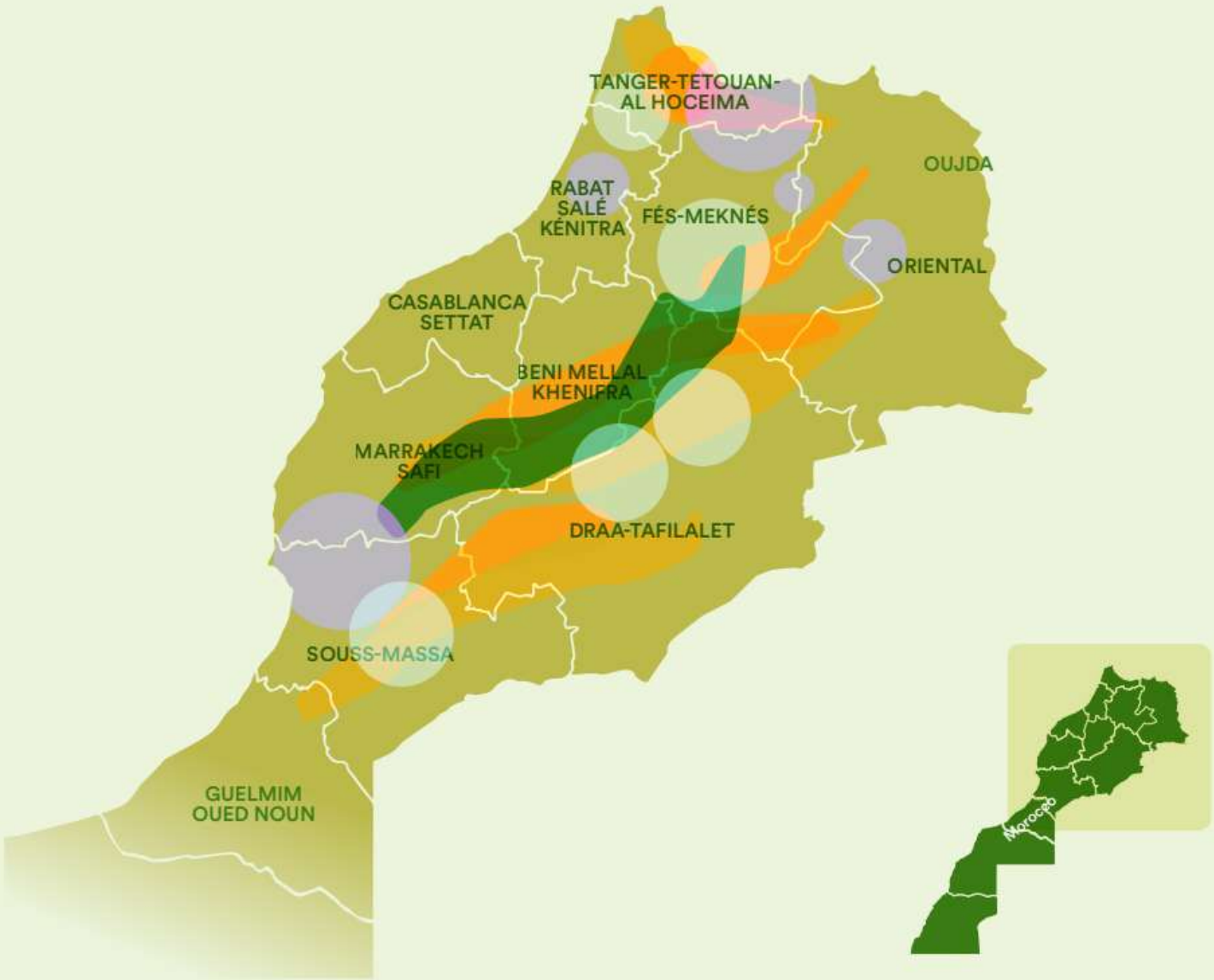
Name in Amazigh:	Talouzet, Louz
Name in English:	Almond tree.
Used parts:	Leaves, fruit, trunk.
Examples of use:	Food, Cosmetic, pharmaceuticals, cattle feed.
Fun Fact:	Sweet almond oil is traditionally used for hair, while bitter almond oil is used for skin.





***5.Lavandula dentata* L.**

Name in Amazigh:	Timzori
Name in English:	Lavender
Used parts:	Leaves, fruit, trunk.
Examples of use:	infusion, incense, and aromatherapy.
Fun Fact:	Lavandula dentata is one of four endemic Moroccan *Lavandula* species.

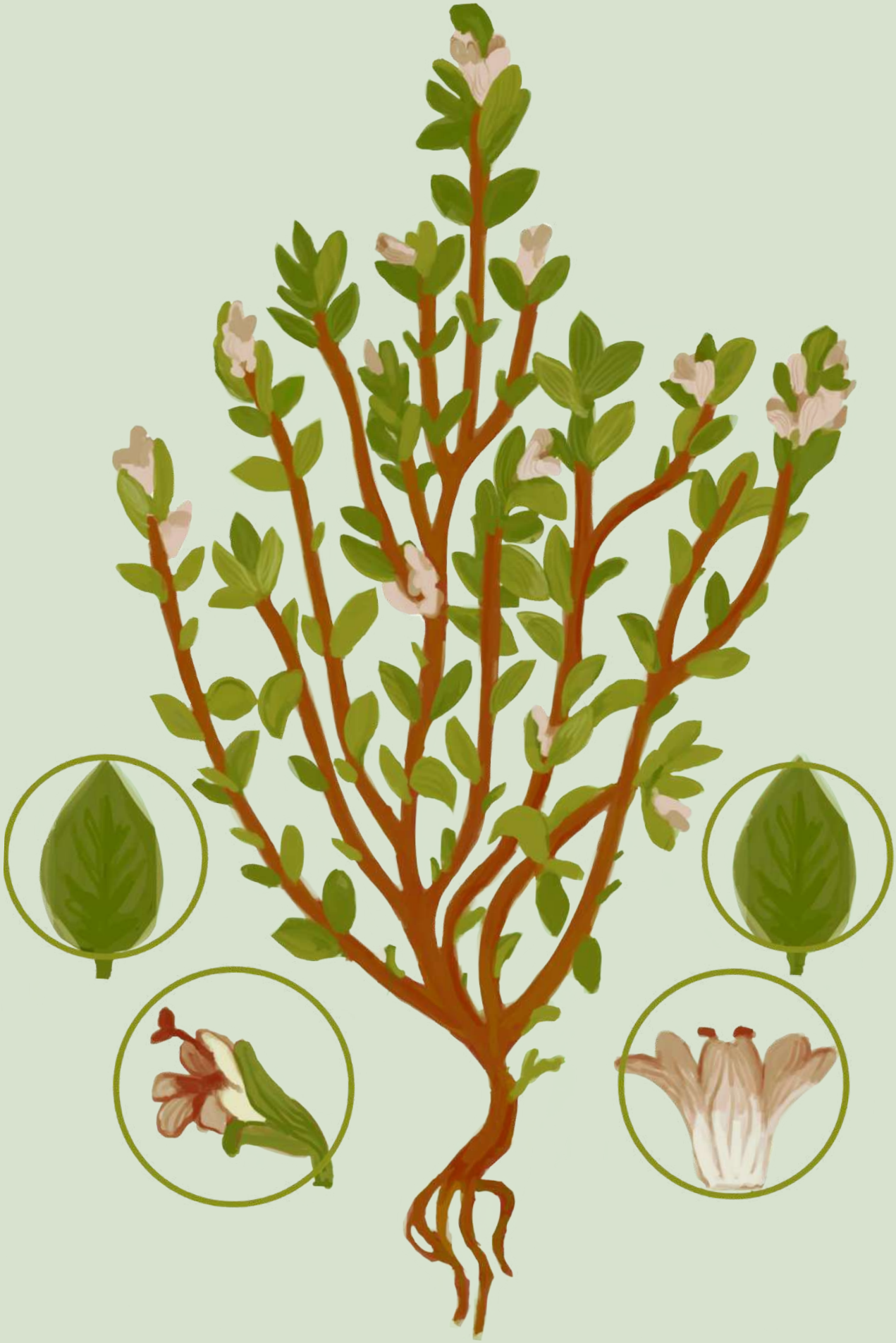


The High Atlas is one of the most diverse biogeographic regions worldwide and are part of the Mediterranean hotspot of biodiversity.
it's the major source of freshwater for the semi-arid plains of central Morocco (Myers et al., 2000).
Elevation: 4,167 m / Area: 77,938 km²

Thyme taxonomy tree:
Clade: Tracheophytes
Genus: Thymus
Species: *Thymus satureioides* L.

Thyme

Thyme in other tongues
In Amazigh: Tazouknit
In French: Thymes
In Arabic: الزعيتره



Thymus saturejoides can be found up to 2,200 m of altitude and its distribution is restricted to the Atlas Mountains and Middle Atlantic of Morocco (Fennane et al., 2007), with its distinctive pink flowers, grows in the sun and dry conditions and in well-drained, rocky soil and it is collected upon the harvest season from mid-May to mid-July. *Thymus satureioides* is used as a traditional medicine in the form of infuses and decoctions to treat whooping cough, bronchitis and rheumatism (Hmamouchi, 2001).

National distribution

Thymus saturejoides can be found up to 2,200 m of altitude and its distribution is restricted to the Atlas Mountains and Mid- dle Atlantic of Morocco.

Source: Fennane et Al., 2007

Medical properties

Antispasmodic
Antibacterial
Antioxidant activities

Astringent
Antifungal
Anti-tabagism

Forms of usage

Herbal tea
Powder or essential oils
Gastrointestinal problems
Spasms
Cough

Bronchitis
Chest infection
Fatigue
Mouth infections
Gingivitis

The dried leaves are sometimes rolled into cigarettes and smoked as a cold and flu remedythe dried leavesare sometimes rolledinto cigarettes and smoked as a cold and flu remedy

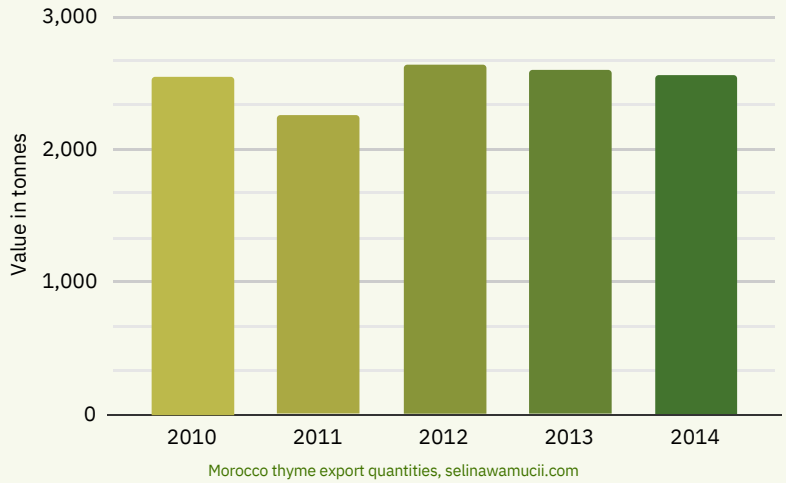
Source: (Essawi; Srour, 2000) (Dob et al., 2006) (Carlini et al., 2006), (Bellakhdar, 1997)

Moroccan Thyme Market Insights

Thymus species (Lamiaceae) are economically important and *Thymus satureioides* is one of the most produced and consumed aromatic herb in Morocco (Lahnine et al., 2016)

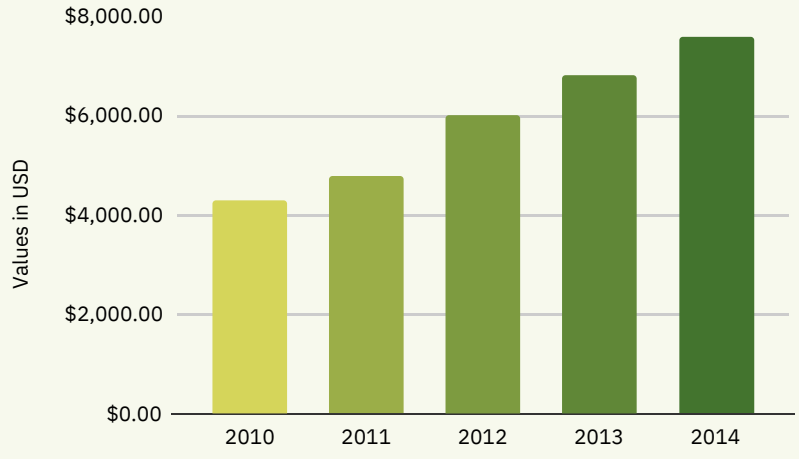
Gender influences income generation. It's mainly explained by the fact that women tend to harvest on the mountains near the village, whereas men tend to collect larger quantities on the higher mountain summits.

Morocco thyme export quantities



Morocco thyme export quantities, selinawamucii.com

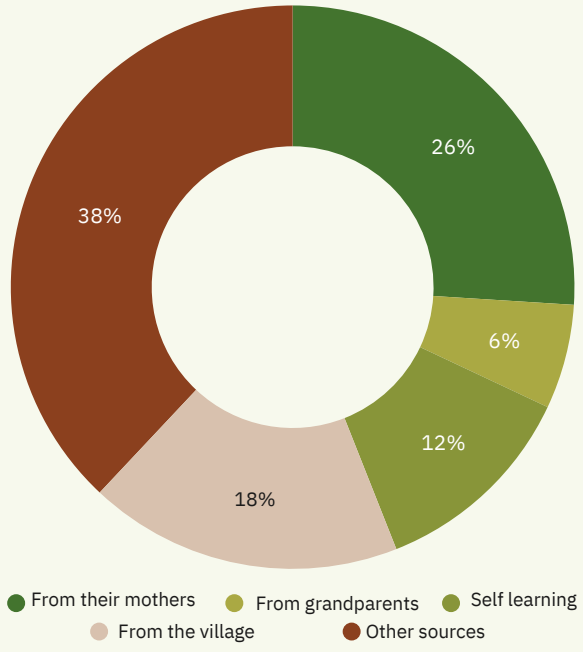
Morocco thyme export values



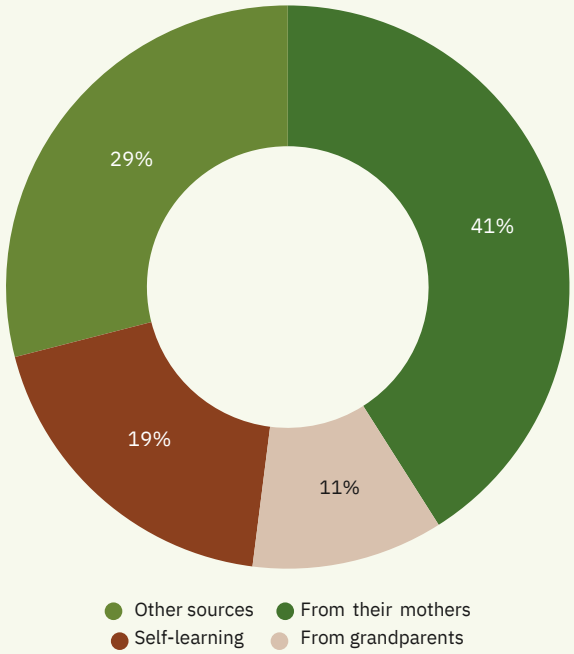
Morocco thyme export values, selinawamucii.com

The transmission of thyme knowledge

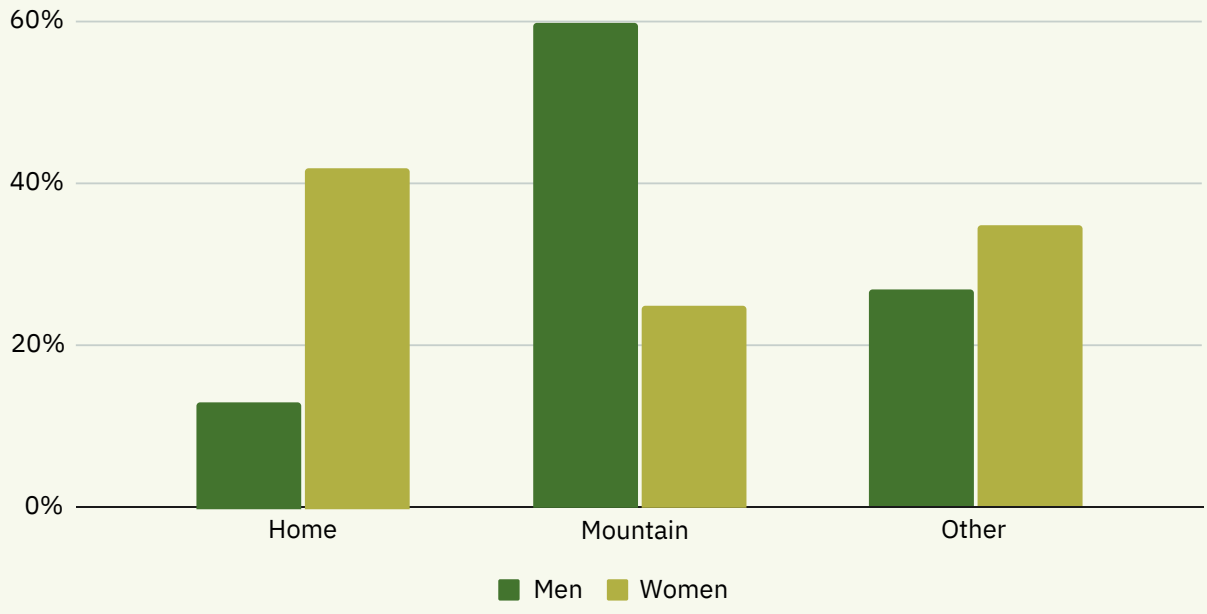
Women learn 41% of their knowledge from their mothers, 11% from grandparents, and about 19% through self-learning and 29% from other sources (friends, herbalists, neighbors...). Men learn 26% of their knowledge from their mothers, 6% from grandparents, and about 12% through self-learning and 18% from the village people and 38% from other sources (friends, herbalists, neighbors...). According to (Montanari, 2016), fathers have less influence on the transmission of traditional knowledge and practices to future generations.



Thyme knowledge transmittion for women



Thyme knowledge transmittion for men



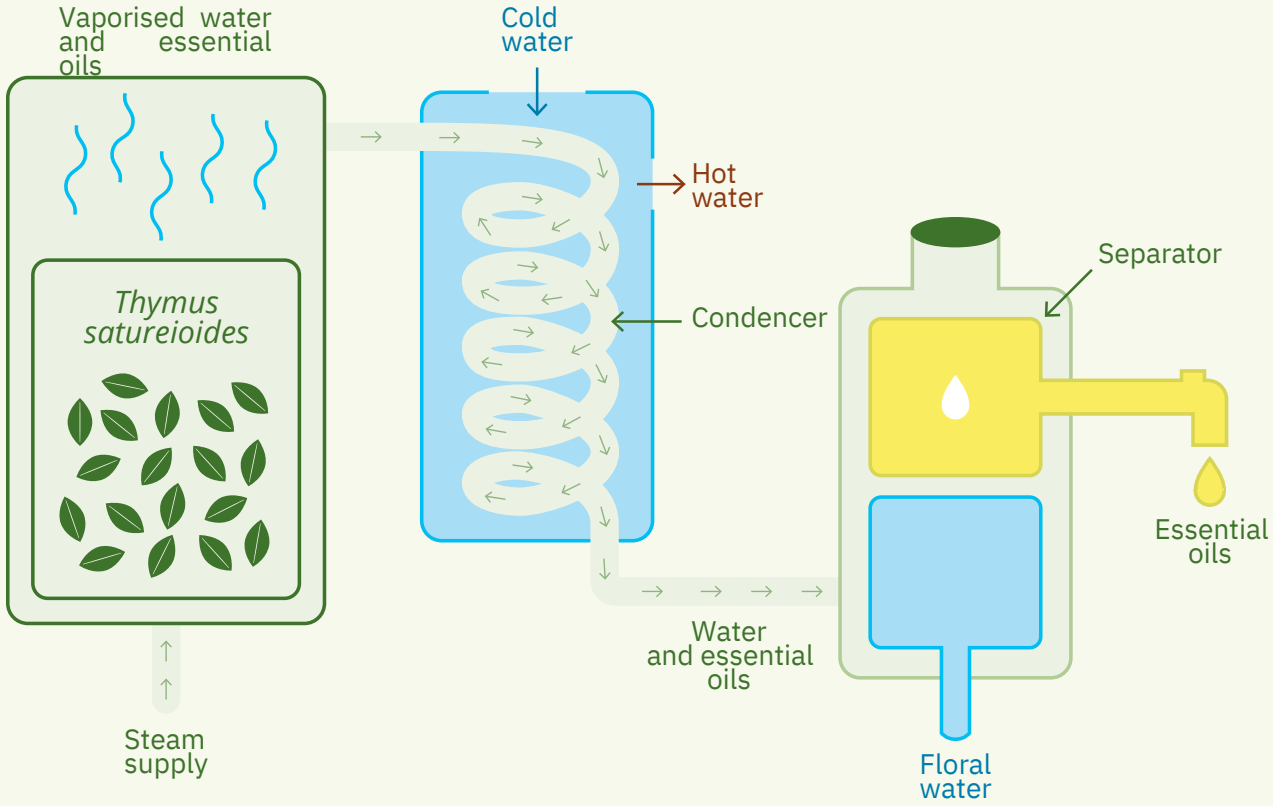
Montanari, 2016

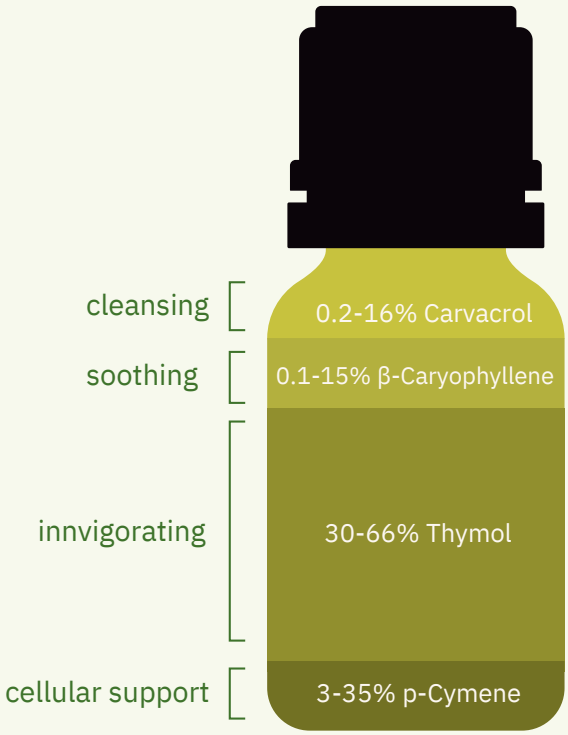
The transmission of knowledge and the preservation of traditional practices centered on plants, mainly thyme in the high atlas, ensures economic well-being and self-sufficiency. Developing a sustainable activity based on the commercialisaton of thyme would also require its cultivation, in order to compensate for its large collection and use.

Thyme valorization

The most common method for extracting the essential oils of *Thymus satureioides* is steam distillation. Water vapor passes through the thyme leaves, causing the cells to burst and release the essential oils, resulting in a "water/Essential oil" mixture. Using the condenser, the water is separated from the organic phase, which is pure essential oil.

Thyme steam distillation process





Chemical Composition:

Thymus satureioides contains 0.5 to 2% essential oil with a variable composition depending on factors such as the vegetative stage, harvest location...
The main chemical components of *Thymus satureioi- des* essential oil is thymol (23 to 40%) and carvacrol (1.8 to 21%)
Thymol acts as a medical disinfectant and can be found as an ingredient in several dental products such as mouthwashes.
Carvacrol possesses a wide range of bioactivities giving *Thymus satureioides* essential oil antimicrobial, antioxidant, and anticancer properties.

Pavida et al., 1976, Belmalha, 2015, Sharifi-Rad M et al., 2018

Graphic Design: Noureddine Jana

Artworks & Illustrations: Zaynab Kriouech

Thyme taxonomy tree:
Family: Rosaceae
Genus: *Prunus*
Species: *Prunus dulcis* (Mill.)

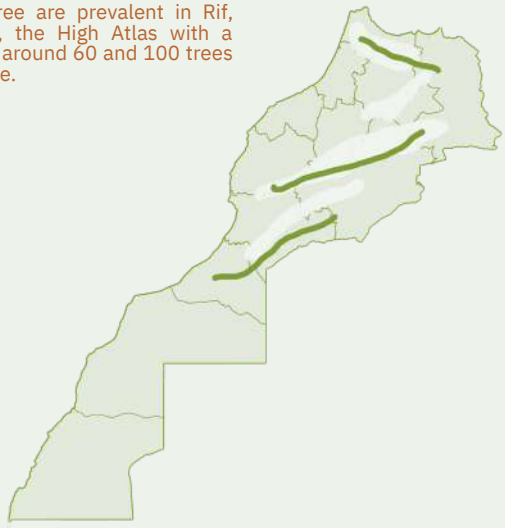
Almonds

Almonds in other tongues
In Amazigh: Louz
In French: Amandes
In Arabic: اللوز

The great diversity of varieties as well as the forms of cultivation and the climatic characteristics determine the remarkable differences in almonds' chemical composition.

National Distribution

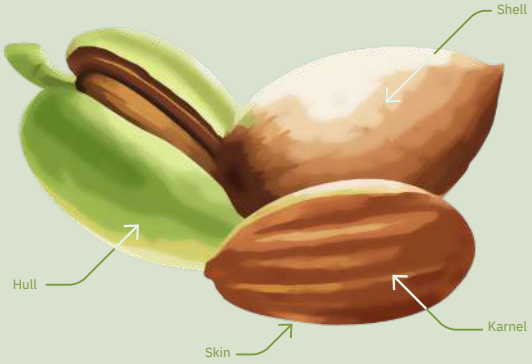
Almond tree are prevalent in Rif, Anti-Atlas, the High Atlas with a density of around 60 and 100 trees per hectare.



Source: Moayedi, A., Rezaei, K., Moini, S., & Keshavarz, B. (2011). Chemical compositions of oils from several wild almond species. Journal of the American Oil Chemists' Society, 88(4), 503-508

The Almond Kernel

The almond kernel is the edible part and is a seed formed by two large cotyledons covered by a brown skin and protected by an external hull, once maturity is reached, the hull opens and the seed separates easily.



Source: Walali & Rakii 2014; Walali et al., 2003; Bulletin mensuel d'information et de liaison du PNTTA, N° 119, Aout 2004.

Almond Trees Planting and Harvest in the High Atlas

Seed planting

Seedling

In the High Atlas, more than half of the almond trees are grown mainly by seed and is the old method of almond trees propagating used by farmers in the High Atlas.

Mature tree

Tree with fruit

Almonds can be harvested before maturity (May-July) or when ripe (August-September) and 1/10 of the harvest is always donated to charity.

Amlou, almond paste from the Southern High Atlas

Amlou is a nutritious snack that can be eaten with bread, added to fruit salads, breakfast cereals or just with a spoon.

Roast
Or fry the almonds

→

Grind
The almonds

→

Mix
The ingredients

→

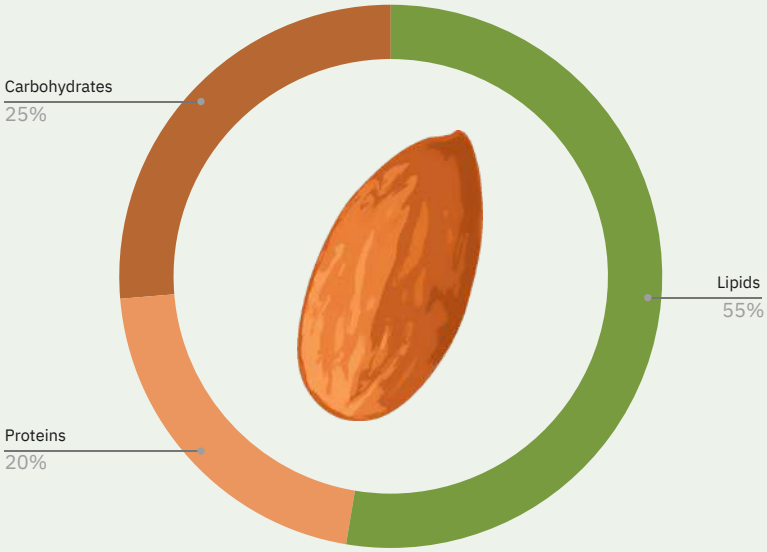
Amlou

Add Argan/vegetable oil + sweetned agenct multiflowered honey or sugar

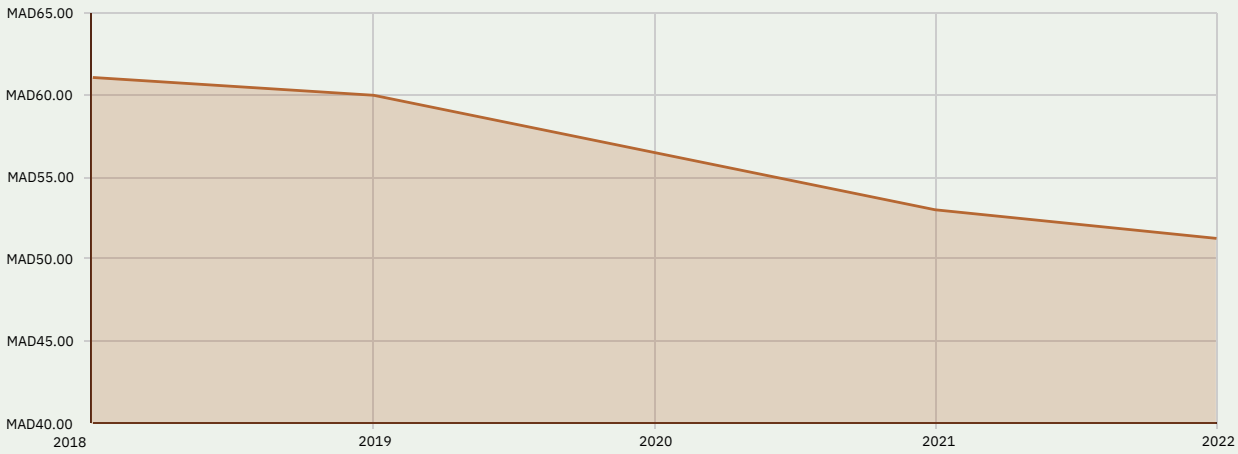
Almonds Components

Studies have reported positive effects of almonds consumption against obesity, hyperten- sion, diabetes and metabolic syndromes.

↘ Low sodium
↗ High potassium
↗ Dietary Fiber
↗ Vitamin E

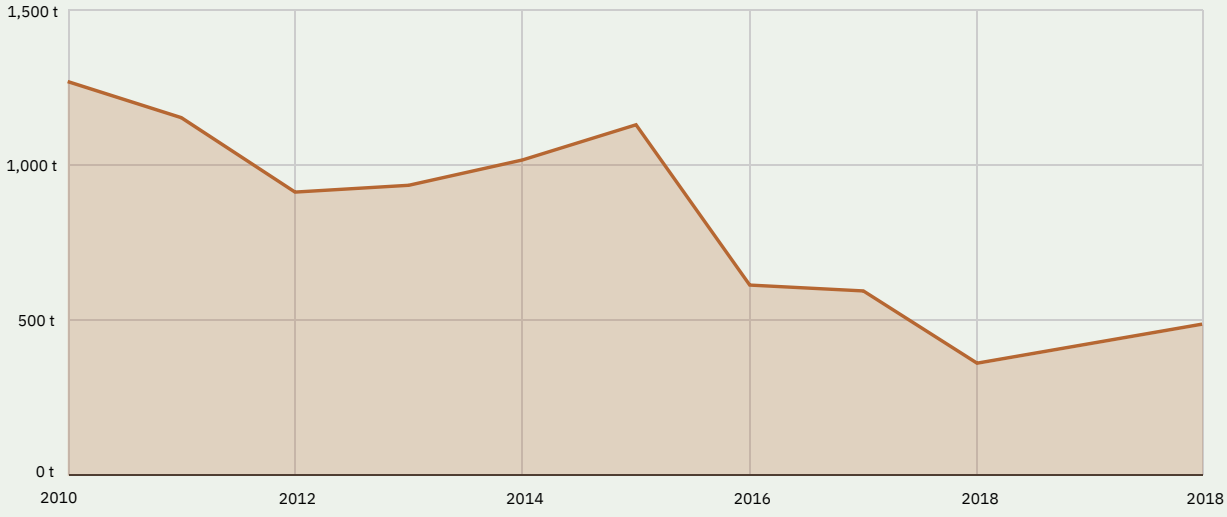


Almods Selling Price Without Hull



Source: Selinawamucii

Moroccan Almond Export



Source: Selinawamucii

Graphic Design: Noureddine Jana

Artworks & Illustrations: Zaynab Kriouech

Walnuts taxonomy tree:
Family: Juglandaceae
Genus: *Juglans*
Species: *Juglans regia* L.

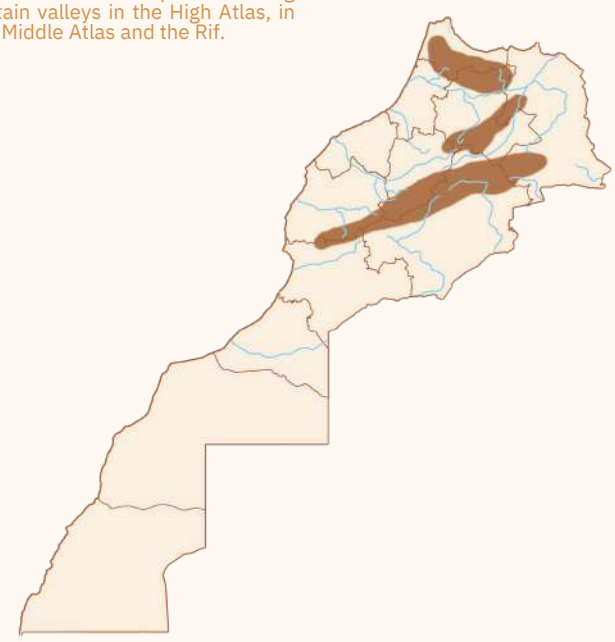
Walnuts

Walnut in other tongues
In Amazigh: Aswik
In French: Noyer
In Arabic: الجوز

In Morocco, the first introduction of walnut is attributed to the Romans!
Morocco is one of the few countries that uses its root for its astringent properties and bark for cosmetics.

National distribution

Walnuts trees are planted along certain valleys in the High Atlas, in the Middle Atlas and the Rif.

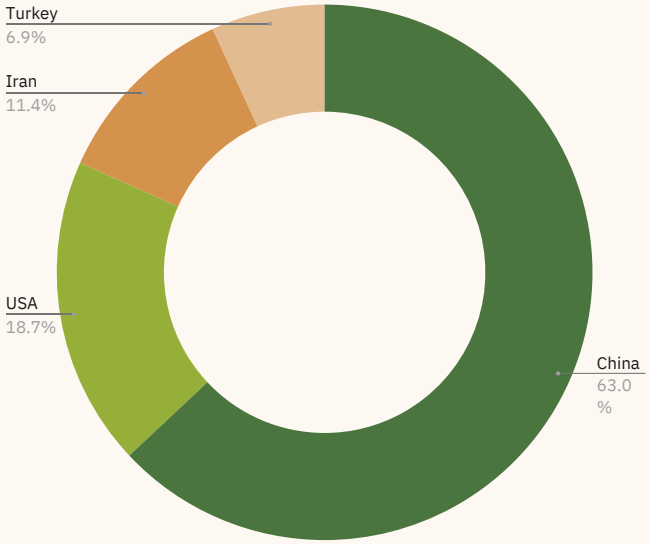


Source: Germain 1992; Kajji, 2014

Global production

The world production of cultivated walnut in 2017 was estimated 3,829,626 tons. However, Morocco is still considered as a lower producer with an annual value of 12,736 tons

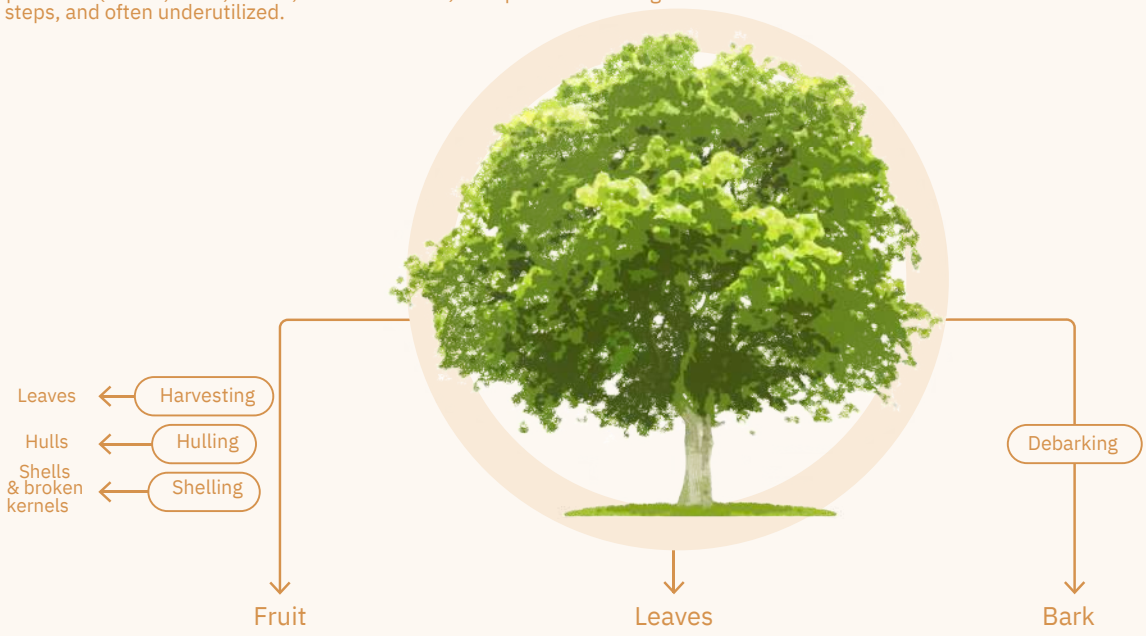
The walnuts kernels selling price in 2019 in the High Atlas was about 50MAD/kg.



FAOSTAT, 2017

Walnut Tree Multiple Use

To extract the edible part (kernels), walnuts undergo several processing operations such as harvesting, hulling, drying, and shelling. A large quantity of by-products (leaves, hulls, shells, broken kernels) are produced during these steps, and often underutilized.



Walnuts provide healthy fats, fiber, vitamins and minerals

Leaves used as remedy against diarrhea, sunburn, itching, etc.

Used as alternative to toothpaste, dye fabric, using grown shells as an exfoliator.

Walnuts Life-cycle in the High Atlas

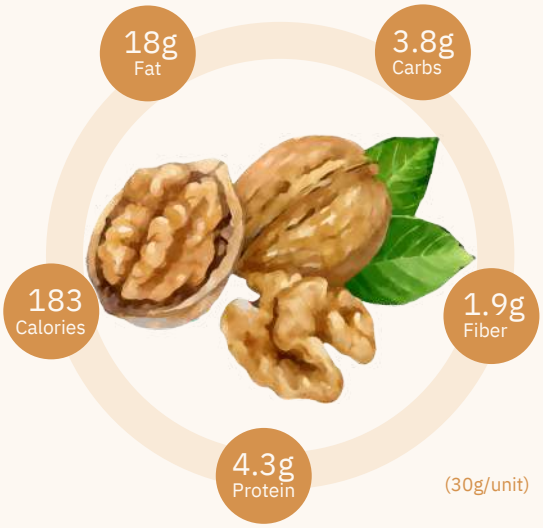
The walnut tree, which is classified as a forest and wild species in the High Atlas, is managed traditionally and does not benefit from maintenance, with harvesting beginning in late September to November depending on the region.

When fields are divided among the community, Azzuwi (harvest) is managed collectively by the population and coordinated by a community guardian (Amchardo), who is paid a percentage of the total harvested amount.

Walnuts, a Nutritional Sweet Snack

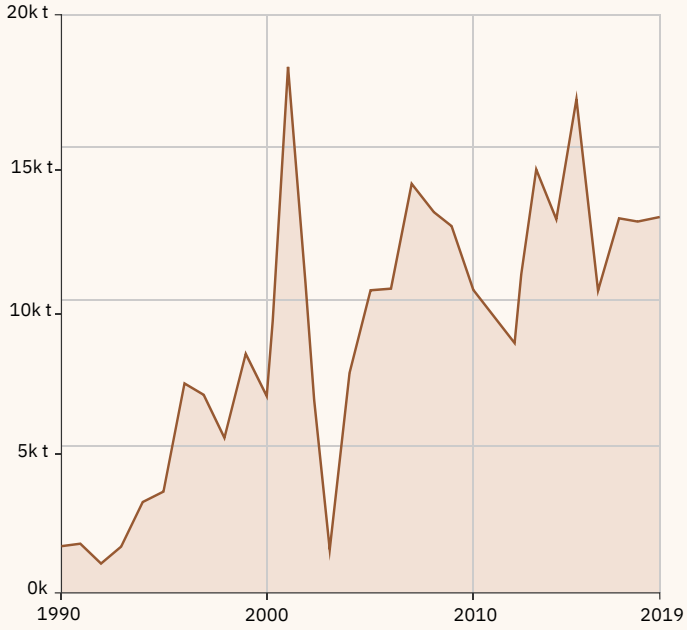
According to research, consuming 20 to 30 grams of walnuts daily protects the body from heart disease, certain cancer types, type 2 diabetes, and other health problems (S. Mehmet & K. Turan 2015).

Cholesterol Free
Sodium Free
Rich in Omega-3 and 6
Vitamin E and B6
Potassium and Magnesium



(30g/unit)

Walnuts Market in Morocco



Evolution curve of walnut production in Morocco from 1961 to 2019 (FAO).

Graphic Design: Noureddine Jana

Artworks & Illustrations: Zaynab Kriouech

Carob

Carob taxonomy tree:
Clade: Rosids
Genus: Ceratonia
Species: *Ceratonia siliqua* L.

Carob in other tongues
In Amazigh: Tikida
In French: Caroubier
In Arabic: الخروب

Male carob trees are sterile and unproductive, female trees are the only ones that produce pods

Global distribution

Carob trees originated in the Middle East and are now grown in Mediterranean climates all over the world.

Source: Batlle and Tous, 1997

National distribution

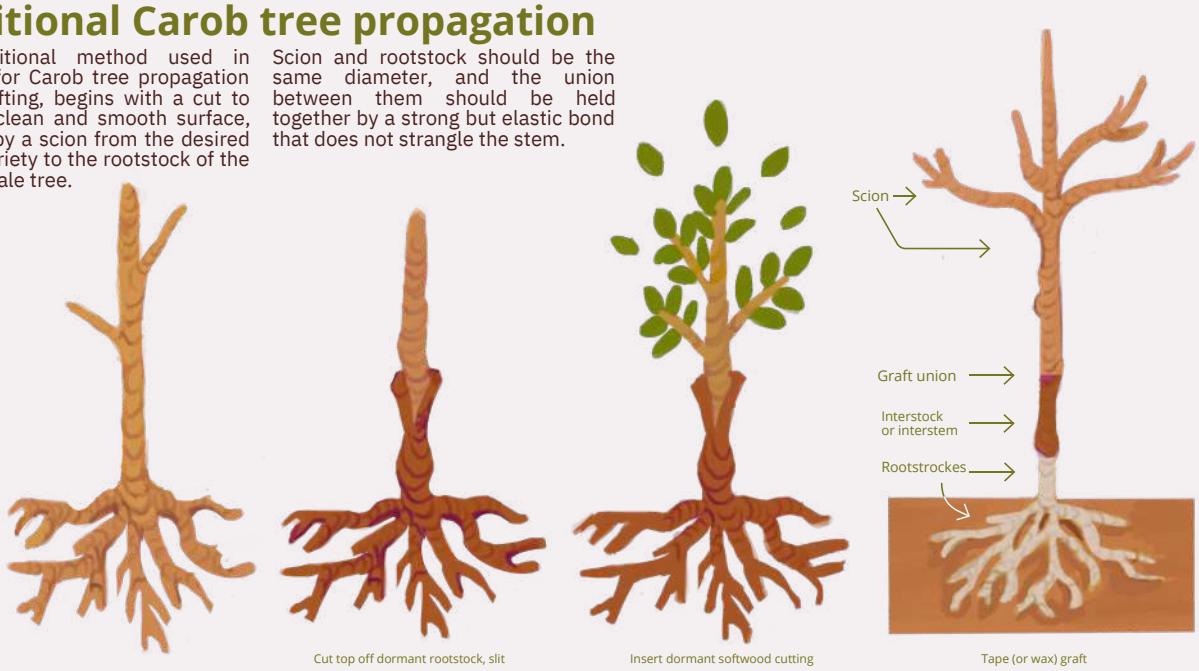
Carob trees grow naturally in the plains and mid-mountains of the Rif, Middle Atlas, High Atlas and Anti-Atlas, and can thrive in arid and semi-arid areas, with hot dry summers.

Source: Fennane et Al., 2007

Traditional Carob tree propagation

The traditional method used in Morocco for Carob tree propagation is slit grafting, begins with a cut to create a clean and smooth surface, followed by a scion from the desired female variety to the rootstock of the hosting male tree.

Scion and rootstock should be the same diameter, and the union between them should be held together by a strong but elastic bond that does not strangle the stem.



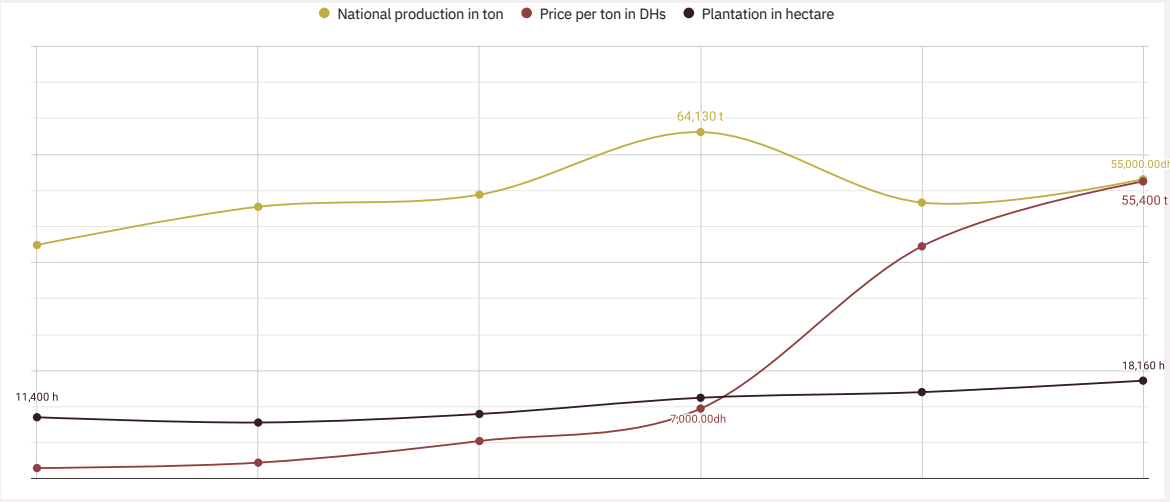
Carob propagation steps trees by grafting

Moroccan Carob sector

The High Commission for Water and Forests puts out a public tender for the carobs grown in the forests every year.

In the forest domain, the pods are harvested by contractors with commission approval, and in the private domain, the farmers harvest the pods themselves.

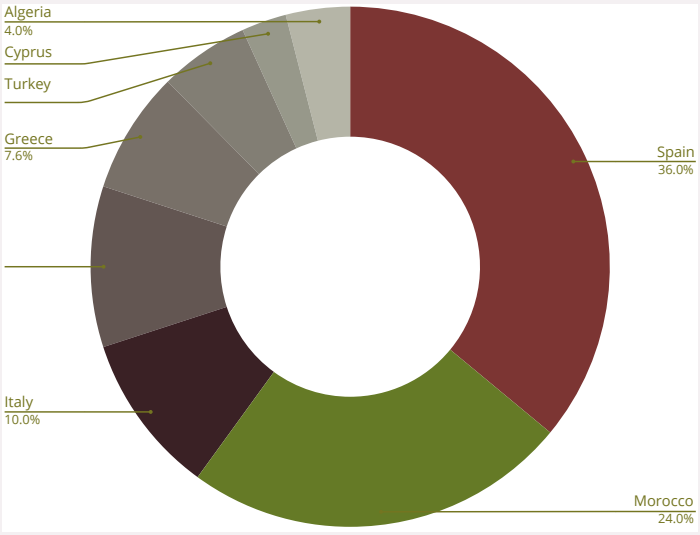
The collection of carob pods takes place in souks by individuals, wholesalers' depots, and cooperatives.



Plantation, price, and national production carob in Morocco

Global Carob production

The global production is estimated to be around 315,000 t per year, produced from approximately 200,000 hectares, with Morocco being the second-largest producer after Spain.



The global carob production of 2017

Carob collectors

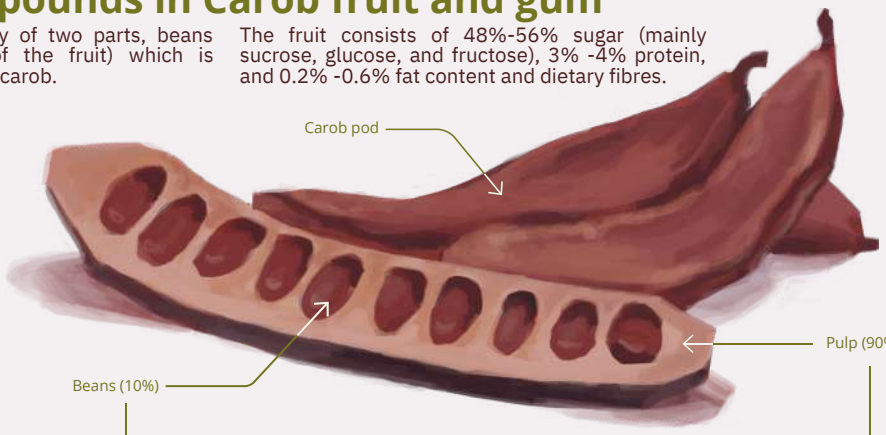
The collection of carob pods takes place in souks by individuals, whole- salers' depots, and cooperatives, which transport the products to various industrial processing and export units.

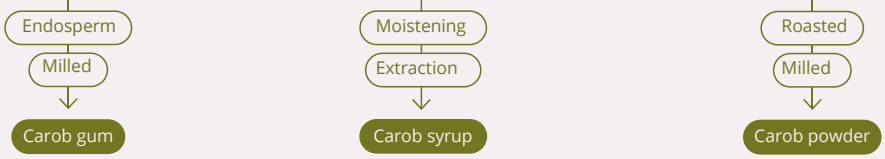
- Souk
- Cooperatives
- Wholesalers
- Individuals

Existing compounds in Carob fruit and gum

Carob fruit consists mainly of two parts, beans (10%) and pulp (90% of the fruit) which is considered a by-product of carob.

The fruit consists of 48%-56% sugar (mainly sucrose, glucose, and fructose), 3% -4% protein, and 0.2% -0.6% fat content and dietary fibres.





0.8g Fibers | 0.8g Carbs | 3 Calories | 1g

71% CarboH | 55% Sugars | 2.94 kcal/g

76% CarboH | 0.8g Fibers | 0.8g Fibers | 3.47 kcal/g

Health benefits:
Preventative role against heart disease.
A better alternative to chocolate which does not cause insomnia, nervousness, or an increase in heart rate.
Suitable for people with celiac disease as it is gluten-free and can be used as flour in baking, cereals, snacks, and more.

Locust bean gum:
Carob gums can be found in ice cream, yoghurt, and sauces.
Each gramme of Carob gum contains 3 calories, 0.8 g of carbohydrates and fibre, 3mg of calcium and 1 mg of sodium.
Helps in digestion thanks to its water retention properties and improves blood sugar levels when consumed in larger quantities.

The syrup has 71 % of carbohydrates including 55% of simple sugars and an energy value of 294 kcal/100 g.
High in d-pinitol, an anti-diabetic agent thus the syrup does not raise blood sugar levels in people with type II diabetes.

Source: Papaefstathiou, E., Agapiou, A., Giannopoulos, S., & Kokkinofta, R. (2018). Nutritional characterization of carobs and traditional carob products. Food science & nutrition, 6(8), 2151-2161. Youssef, M. K. E., El-Manfaloty, M. M., & Ali, H. M. (2013). Assessment of proximate chemical composition, nutritional status, fatty acid composition and phenolic compounds of carob (*Ceratonia siliqua* L.). Food and Public Health, 3(6), 304-308.

Graphic Design: Noureddine Jana

Artworks & Illustrations: Zaynab Kriouech

Lavender taxonomy tree: Clade: Eudicots
Order: Lamiales
Genus: *Lavendula*
Species: *Lavandula dentata* L.

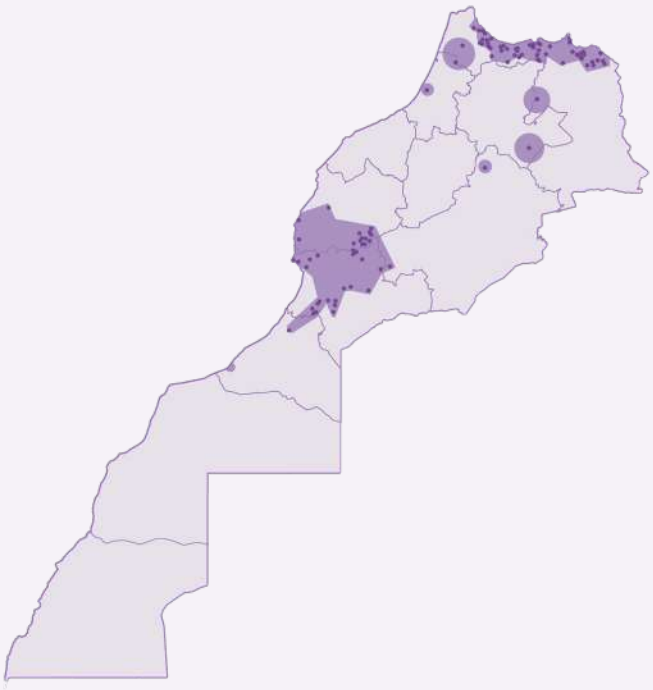
Lavender

Lavender in other tongues
In Amazigh: Timzori
In French: Lavande
In Arabic: الخزامة

Lavandula dentata ia is an endemic species of Morocco growing spontaneously in the Rif, Anti Atlas, Souss Valley and in the southern part of the High Atlas Mountains.

National distribution

The natural habitat of *Lavandula dentata* is limestone soils in sunny open spaces, pastures, bushes, or low bushes.



Source: Upson Tim & Jury, Stephen. (2002). A Revision of Native Moroccan Species of Lavandula L. section Pterostoechas Ging. (Lamiaceae). Taxon. 51. 309. 10.2307/1554929

Local use of *Lavandula dentata* and healing properties

What it Can Do for You

Increases stamina and energy. It is ideal for relaxing and unwinding

Enhance the falvor of food
Ward off disease

Healing Properties

Relieves spasms, stress, headaches, and rheumatism,

Treating colds, respiratory conditions, and stomach upset.

Essential oil, herbal teas and infusions, creams and lotions,

Powder and dried flowers (for culinary and cosmetics purposes), incense

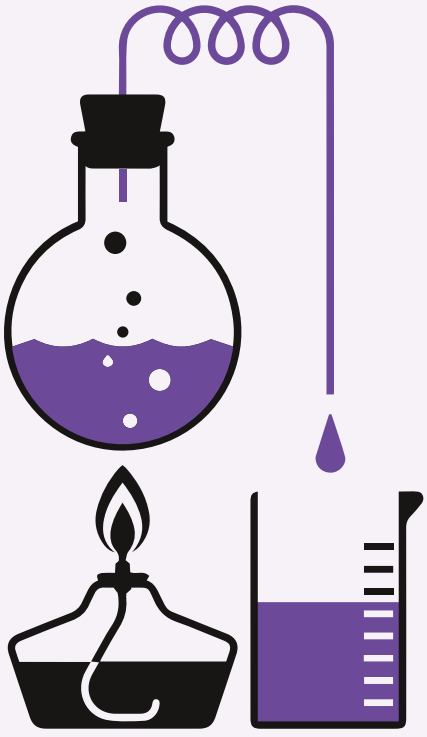
Safety

For people with diabetes, epilepsy, or seizure disorders, use only under the supervision of a physician. Do not ingest its essential oil. To be avoided during pregnancy.

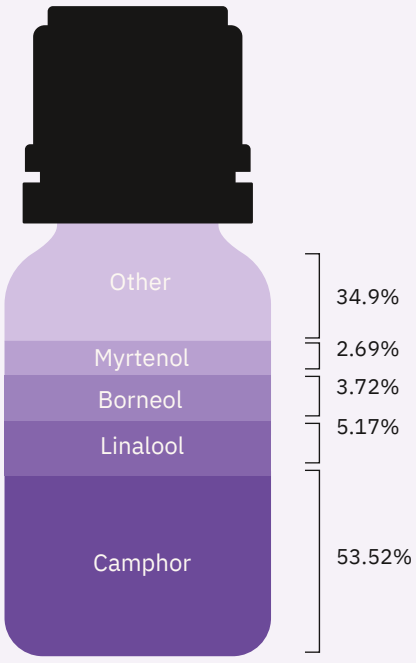
Guitton, Y. (2010). Diversité des composés terpéniques volatils au sein du genre Lavandula: aspects évolutifs et physiologiques. (Doctoral dissertation, Université Jean Monnet-Saint-Etienne).

Essential oils as a valuation approach for *Lavandula dentata*

Lavandula dentata
Plant



Lavandula dentata
Essential Oil

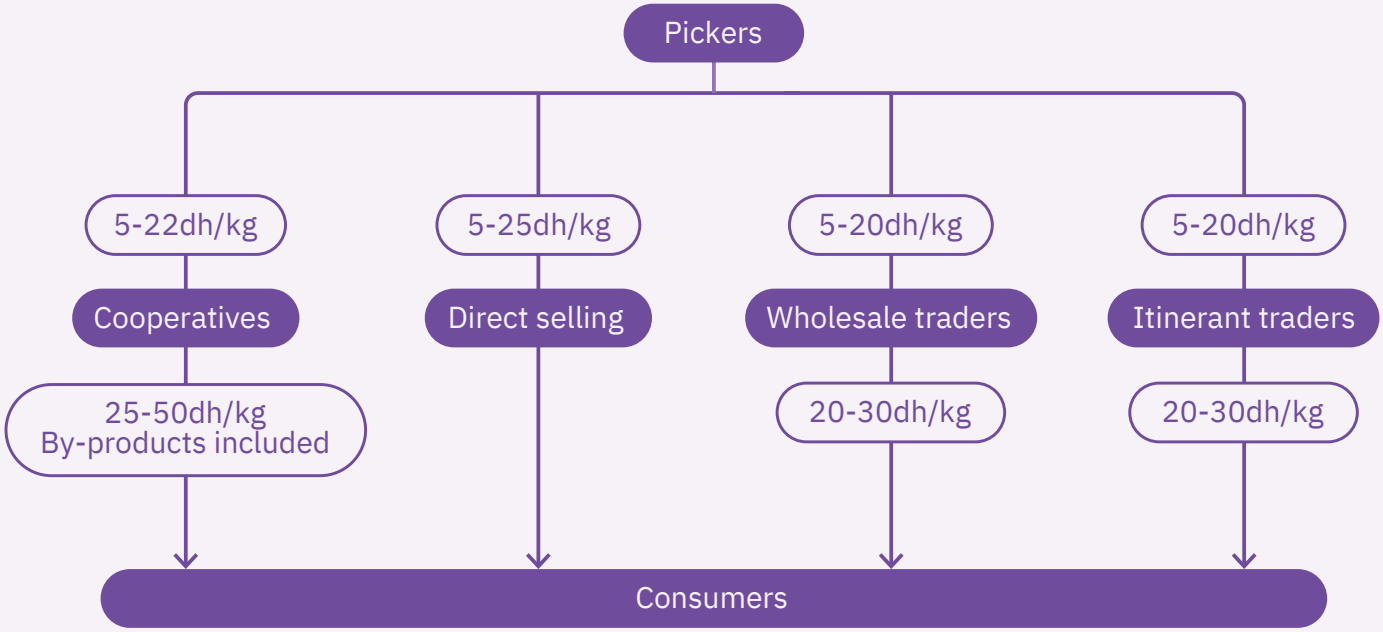


Source: Cavanagh, H.M. A., & Wilkinson, J.M. (2002). Biological activities of lavender essential oil. Phytotherapy Research, 16(4), 301-308.

Moroccan *Lavandula dentata* Commercialisation Potentiel

In 2019, dried lavender flowers were sold in the High Atlas for 9 to 13 MAD/kg, depending on the quality of the flowers. *Lavandula dentata* is regarded as one of the plants that generate significant income for 70% of the local population in the High Atlas.

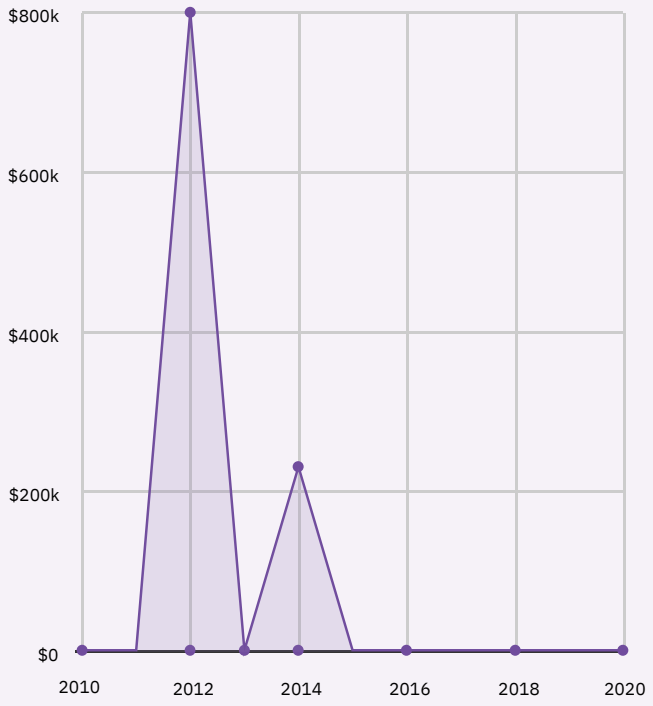
Marketing channels are complex and dominated by intermediaries, resulting in very low profit margins for the initial producers and a non-uniform and varying selling price on the local market.



Source: Cavanagh, H.M. A., & Wilkinson, J.M. (2002). Biological activities of lavender essential oil. Phytotherapy Research, 16(4), 301-308.

Moroccan *Lavandula dentata* Commercialisation Potential

Lavender oil exportation from various species has been decreasing since 2012, and it has now completely stopped.

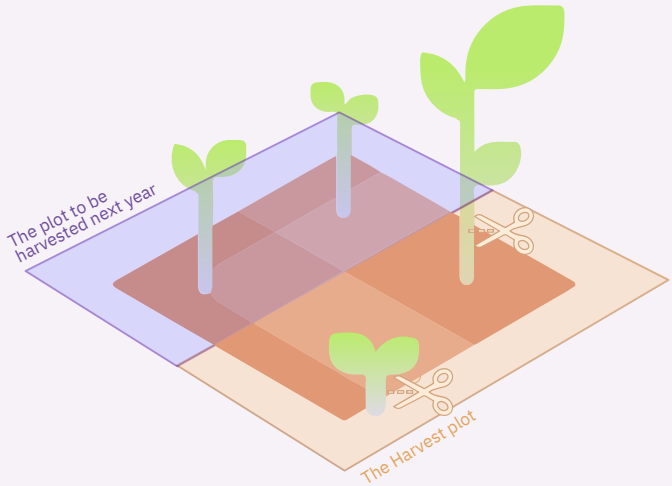


Source: selinawamucii.com

Lavender related harvesting practices

In the High Atlas, well-defined plots are harvested for the regeneration of *Lavandula dentata* in the forest, while other plots are left to be harvested the following year.

Lavendula dentata blooms from mid-June to mid-July and is harvested during the same time period, yielding 20 to 100 kg of fresh lavender flowers per person.



Source: selinawamucii.com

Graphic Design: Noureddine Jana

Artworks & Illustrations: Zaynab Kriouech