Enhancing the value of argan oil is the best mean to sustain the argan grove economy and biodiversity, so far

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Abstract: *In Morocco, the region covered with argan trees is named the argan grove. Its long-term preservation depends on the discovery of new and economically rewarding markets to sell argan tree produces. At the present time, the argan oil appears to be the best candidate to fulfill this task. The scientific results that have allowed the emergence of argan oil on the international edible and cosmetic oil markets are reported together with recent analytic results. Alternative approaches, not based on argan oil marketing but also aimed at safeguarding the argan grove, are also reported.*

Key words: *Argan tree, edible oil, cosmetic oil, saponin, arganine*

The argan tree (*Argania spinosa* (L.) Skeels, sapotaceae) is endemically growing only in Southwestern Morocco. The area covered by the argan forest, also named the argan grove, has the shape of an isosceles triangle, the base of which being along the Atlantic Ocean and its third summit being 100 km away, east from the coast. The argan grove has a superficy of 800,000 ha and is in a region where the association of subtropical temperatures and oceanic moisture creates a unique ecosystem that was recognized by the UNESCO as a biosphere reserve in 1998. The argan tree is particularly well adapted for this kind of environment since its deep rooting system allows the survival of the tree on poor and dry soils while limiting erosion and desertification. Over the years, an agroforestry system based on the argan tree has prospered. The tree was providing its wood as fuel and for construction, its leaves as forage, its shadow for protecting family-scale culture, and its fruits to prepare argan oil. However, nowadays this forestry system is no longer at equilibrium and the argan grove is severely endangered. Its supercify is constantly shrinking and the tree density is permanently decreasing. This is due to the unfortunate combination of multiple factors including several consecutive extremely arid years, lack of care and over-exploitation of the trees by the local population, lack of long-term management of the argan forest by the administrative autorities until the 1980s, and the culture of water-gobbling vegetable mainly to satisfy the need of the fast-booming tourist industry. To inverse this dramatic trend and rescue the argan grove as well as its population, and ultimately stop the desert progression in Southwestern Morocco, a nation-wide program has been initiated in Morocco in the late 1980s. This program was based on the assumption that only an increase in the argan tree monetary value could save the argan forest, and that the local population would actively adhere to this program only if they were directly benefiting of a major part of the expected financial outputs. The next pages describe the main achievements of this program and the work that still needs to be done before its final completion.

What could enhance the argan tree value?

Argan tree secondary metabolites

The discovery of new marketable argan tree derivatives or of new market niches was a prerequisite to justify the domestication of the tree and its reimplantation on large areas. To have a chance of enhancing the argan tree value, it was necessary either to identify new outputs possibly different from those traditionally known or to strongly improve the commercial value of the known ones. Both ways have been explored for fifteen years and are still currently explored. The systematic phytochemical analysis of all argan tree parts was undertaken to identify new secondary metabolites possibly allowing the development of new outputs. Because all members of the sapotaceae family contain a high level of saponins and because saponins possess numerous biological activities [1], this class of compounds was the first to be investigated. Indeed, the presence of high levels of saponins belonging to the Δ-12 oleanane subgroup was rapidly confirmed. Successive studies allowed the identification of new saponins: five from the argan kernels [2], eight from its trunk [3, 4], two from its seed shell [5], one from its seed pulp [6] in addition to several already known saponins [7]. Although most of these saponins display antiinflammatory and antifungus properties, their biological activity is not efficient enough to justify further developments in this field. More interestingly, one of the argan saponins, named arganine C, has shown strong inhibitory properties against HIV entry into cells in a cell fusion assay [8] and a mixture of argan saponins has been shown to possess lipolytic activating properties on human adipocytes as well as DNA protective effects against UV-B [7, 9]. Such results could lead to the development of argan secondary

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metabolites in the highly lucrative drug or cosmetic fields. However, though highly promising, these results are too preliminary to ascertain the economic future of the argan grove on the short term. Consequently, other metabolites are currently also actively explored to enhance argan tree value.

Flavonoids constitute the second class of argan metabolites currently actively investigated and considered as able to provide a direct access to a viable market. The recent discovery of the anti-collagenase activity of the crude flavonoid fraction of argan leaves has led to envisage their introduction in cosmetic preparations [10]. However, as mentionned for the saponins, the possibility of sustainable incomes from an industrial use of argan leaves remains remote and uncertain.

Improvement of traditionally known uses of argan derivatives is therefore a method that should not be neglected to ensure the argan grove preservation.

Argan oil

Argan oil has been traditionally used by the argan forest dwellers for centuries [11]. It is prepared by pressing argan fruit kernels. When carried out on a family scale, argan oil preparation is exclusively performed by women. Recent improvements that do not alter the oil physico-chemical properties [12] have been brought to the oil preparative process and, to respect the tradition, implemented in women rural cooperatives. Both extraction methods have already been described in full details [13, 14]. Even though some amount of mechanization has been introduced for some the preparative steps, the full process remains slow and requires the collect of huge quanties of kernels. This explains the elevated price of the oil.

Two kinds of argan oil can be found on the market: the cosmetic or edible argan oil. Both oils are virgin (cold-press) oils but cosmetic grade argan oil is prepared from non-roasted argan kernels whereas edible argan oil is prepared by pressing slightly roasted kernels. This step dramatically modifies the taste of the edible oil and is responsible for its unique hazelnut taste and flavor. Chemical investigation of the odorants contained in edible and cosmetic argan oil has evidenced composition differences even though the odorant(s) responsible for the hazelnut flavor has(ve) not been identified yet [15].

Argan oil density at 20°C is between 0.906 to 0.919; its refractive index is 1.463-1.472. Extra virgin argan oil has an acid value lower than 0.8 [16]. Glycerides, including 95% of triglycerides, constitute 99% of argan oil. The main fatty acids in argan oil are oleic acid (46-48%), linoleic acid (31-35%), palmitic acid (11-14%), and stearic acid (4-7%) [9, 17]. Because argan oil is not refined, it still contains 1% of unsaponifiable matters. They include carotenes (37%), tocopherols (8%), triterpene alcohols (20%), sterols (29%), and xantophyls (5%). Tocopherol level is between 600 and 900 mg/kg. The main tocopherol found in argan oil is γ-tocopherol (between 81 and 92%) [18], it is a strong anti-oxidative agent. α-, β-, and δ-tocopherols represent 2.4 to 6.5%, 0.1 to 0.3%, and 6.2 to 12.8%, respectively, of the total tocopherol fraction. The simultaneous presence of high levels of unsaturated fatty acids, γ-tocopherol, and sterols is currently believed to be the reason for the hypocholesterolemiant, hepato and cardioprotective properties of argan oil [19, 20]. These compounds could also provide a cancer chemoprotective effect [21].

Research on argan oil currently in progress

The main concerns currently addressed to argan oil are 1) the certification of its purity and 2) its preservation. The elevated price of argan oil makes it particularly prone to adulteration. A simple fatty acid analysis is not sufficient to certify the argan oil authenticity since several vegetable oils have a sufficiently close composition so it could be possible to obtain a similar composition by mixing cheap oils in calculated amounts. It has recently ben shown that campesterol, a sterol common in all ordinary vegetable oils, is lacking in argan oil composition. Since campesterol can be easily detected by gas-chromatography analysis, a method taking advantage of the lack of campesterol has been recently proposed, together with a fatty acid composition analysis, to detect argan oil adulteration [22].

Because of its high content in tocopherols and phenols, two families of antioxidant derivatives, argan oil preservation time can be expected to be long. The short preservation time observed for the traditionally prepared oil is directly related to the addition of water during the extraction procedure. Water-addition being suppressed in the rural women cooperatives, argan oil preservation ability is now strongly improved. Nevertheless cosmetic and edible argan oils have a quite different preservation time, the shelf life of edible argan oil being twice longer than that of the cosmetic oil. The oil peroxide index can be used to monitor the oil preservation ability. Comparison of the peroxide index of cosmetic *vs* edible argan oil samples stored at 25 °C in brown-colored or clear glass under inert atmosphere have demonstrated that whereas freshly prepared edible and cosmetic argan oil samples have similar peroxide index, after three months, the peroxide index of cosmetic oil is threefold (dark glass) to fourfold (clear glass) higher than that of edible argan oil after the same amount of time. This clearly shows that the sunlight has some incidence on the peroxide index (preservation time) and sugggests that an additional factor intrinsec to the oil is responsible for the difference in preservation time. The hypothesis of the formation of derivatives having high preservative properties or of the destruction of strongly but still unknown oxidative agents during the roasting step is currently investigated, as well as other hypotheses.

Conclusion

On the short-term, the future of the argan grove appears to be secured by the economic success of argan oil. However linking the argan grove preservation to a single produce, whatever its quality can be, is highly dangerous. Efforts are currently performed in Morooco to certify the oil quality, and consequently ascertain consumer fidelity. The recently obtained Geographic Indication of argan oil is also a positive factor that is likely to satisfy the consumers. However, on a long-term standpoint, it is still necessary to identify new derivatives allowing the enhancement of the argan tree value and hence avoid fluctuations on the oil market that, as it is now, could be fatale in case of consumer disaffection. For the moment, leaf flavonoids appear to be the best candidates to ensure this function.

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