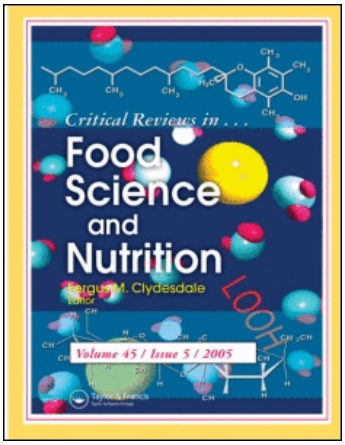

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Zoubida Charrouf [a];Dominique Guillaume [b]
[a] Laboratoire de Chimie des Plantes, Faculté des Sciences Mohammed V-Agdal, Rabat, Morocco [b] Laboratoire de chimie Théraputique, CRNS-Unité mixte de recherche 6229, UFR Médecine-Pharmacie, Reims, France

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Should the Amazigh Diet (Regular and Moderate Argan-Oil Consumption) have a Beneficial Impact on Human Health?

ZOUBIDA CHARROUF[1] and DOMINIQUE GUILLAUME[2]

[1]Laboratoire de Chimie des Plantes, Faculté des Sciences Mohammed V-Agdal, Rabat, Morocco
[2]Laboratoire de chimie Théraputique, CRNS–Unité mixte de recherche 6229, UFR Médecine–Pharmacie, Reims, France

Virgin argan oil, cosmetic or dietary grade, is prepared by cold-pressing the kernels of argan fruits. Both types of oil, traditionally used by the amazighs (the argan grove traditional dwellers), are now available on the shelves of the most-developed country stores. Argan oil contains a high level of oleic and linoleic acid and is also particularly rich in phenols. Since these metabolites are currently considered as essential to explain some of the protective effects against cancer and coronary heart disease attributed to other oils, similar effects can be expected from argan oil consumption as suggested by the amazigh medicine claims. Interestingly, argan oil content in γ-tocopherol is much higher than that of any other oils. γ-Tocopherol has recently been shown to possess strong chemopreventive and anti-inflammatory properties. This indicates that argan oil should readily find a place of choice amid the most profitable oils for human health. Because of its reduced geographical origin, the chemical composition (major as well as minor components) of argan oil is also highly reproducible. Therefore argan oil consumption should confer health benefits in a reliable and efficient manner.

Keywords Nutraceutic, tocopherol, chemoprevention, cardiovascular disease, dietary oil

INTRODUCTION

The beneficial health effects of the Mediterranean (Cretan) diet are commonly attributed to the association of steady physical activity with a complex combination of several dietary characteristics (Keys et al., 1981; Marckmann and Astrup, 2000). These latter mainly include a high level of fibers (coming from fruits, vegetables, and bread), a low content of saturated fat, and olive oil consumption (Astrup et al., 2000). Regular and moderate olive oil consumption is also currently believed to be one of the factors actively participating in protective effects against urogenital or digestive cancers, coronary heart diseases, and cell aging (Owen et al., 2000a). High levels of unsaturated fatty acids have originally been considered as the main parameter linking oil consumption and observed pharmacological effects (Martin-Moreno et al., 1994). Recent chemical and pharmacological investigations have also clearly related the bioactive properties of oil to the presence of small but essential quantities of (poly)phenol derivatives (Owen et al., 2000b and 2000c).

Argan oil consumption has recently spread in the European oil-market. It is also easily found in gourmet-stores in Japan and North-America. Argan oil is a virgin oil. This means that it is obtained using a cold-pressed technique (Charrouf et al., 2002) and consequently that the oil is not altered during the extraction step (Codex Alimentarius commission, 2003). Additionally, any refining step is included in the argan oil preparative process. This explains why it contains high levels of (poly)phenols. Argan oil is produced from the fruits of the argan tree (*Argania spinosa* (L.) Skeels), a tree that naturally exclusively grows in Morocco. Although, it is a "living product" whose composition inevitably undergoes slight variations (Hilali et al., 2005), argan oil composition (Charrouf and Guillaume, 2002) is particularly homogenous and not affected by geographical or genetic considerations (Table 1). Therefore, argan oil consumption is frequently recommended to avoid diet-related chronic diseases and is often considered as the best oily nutraceutic (Khallouki et al., 2003, 2005). This article describes the recently published scientific reports evidencing the

Address correspondence to Zoubida Charrouf, Departement de Chimie, Faculte des Sciences, Universite Mohammed V, Rabat Agdal, Morocco. E-mail: zcharrouf@menara.ma

Table 1 Comparative fatty acid composition of argan, olive, and (conventionnal and genetically selected) sunflower oils.

			Sunflower oil	
Fatty acid	Argan oil	Olive oil	Conventionnal	High oleic
Oleic acid	43–49%	55–83%	15–25%	75–85%
Linoleic acid	29–36%	3.5–21%	62–70%	7–17%
Palmitic acid	11.5–15%	7.5–20%	5–8%	3–5%
Stearic acid	4–7%	0.5–5%	4–6%	3–4.5%
Unsaponifiable matter	1.1%	<1.5%	<2%	

possibly beneficial impact of argan oil consumption on human health.

DISCUSSION

Argan Oil

Argan oil results from the pressing of the kernels contained in the argan fruit stones. If first roasted for a few minutes, the kernels deliver an edible-grade oil whereas pressing the fresh kernels affords a more bitter cosmetic-grade oil. Because the (roasted) kernels are cold-pressed, argan oil is not thermally altered during its extraction and thus belongs to the virgin oil family. Extra-virgin argan oil, a nomenclature frequently used by oil retailers, refers to an argan oil whose acidity value is lower than 0.8 (Norme marocaine, 2003). Virgin argan oil has an acidity value lower than 1.5 (Norme marocaine, 2003).

Cosmetic and alimentary argan oil have been prepared for centuries on a family scale by the natives from South-Morocco (Amazigh population) for whom argan oil consumption has been the main intake of lipids for centuries (Charrouf et al., 2002). Amazigh medicine recommends the daily consumption of argan oil to prevent heart diseases, reduce blood-cholesterol level, and treat rheumatism-induced pain (Charrouf and Guillaume, 1999). As an ointment, cosmetic grade argan oil is used to treat chicken pox or acne scars, to cure chapped-skin and eczema, and to prevent wrinkle formation (Charrouf and Guillaume, 1999). Dipping fingernails in cosmetic argan oil is also recommended to treat weak nails (Charrouf and Guillaume, 1999). The rudimentary method traditionally used to prepare argan oil has prevented its distribution out of the Moroccan market for a long time. During the last fifteen years, some amount of modern technology has been progressively instilled in the oil preparation process (Charrouf and Guillaume, 2008) and, nowadays, high quality cosmetic and dietary virgin argan oil can be easily purchased in the Japanese, American, and European markets. Prices up to $40/100 ml are frequent for the cosmetic grade oil making it one of the most expensive oils in the world; dietary argan oil is hardly cheaper.

Cosmetic Argan Oil

The real efficiency of argan oil as a cosmetic is somehow difficult to scientifically assess and, so far, only the sebum regulating property of the oil has been reported (Dobrev, 2007). In this study, nineteen of the twenty volunteers mentioned a sebum regulating efficiency accompanied by a reduction in the casual sebum level and in the area covered by oily spots. A better indicator of the efficiency of argan oil as cosmetic is more likely to be the six patents on argan oil which are presently held by major cosmetic laboratories that share a niche market annually evaluated to a few millions of American dollars.

Edible Argan Oil

With high-quality edible argan oil becoming easily available, the exploration of its pharmacological properties has become possible. Likely due to the traditional claims and the high disease frequency, the antihypertensive and hypocholesterolemiant properties of argan oil have been the first to be scientifically evaluated. In 2000, a study using spontaneously hypertensive rats and *Meriones shawi* rats exhibiting hypertension, dyslipidaemia, and hyperinsulinemia induced by a hypercaloric diet, evidenced that the daily ingestion of argan oil at a dose of 5 ml/Kg for two months, had a significant impact on the plasmatic factors of these rats, including a decrease in glycemia, plasmatic cholesterol, LDL-cholesterol, blood pressure, and insulinemia (Berrada et al., 2000). Using a dose of 10 ml/Kg, and on *Meriones shawi* rats, similar effects were observed together with a concomittant reduction of body weight, which is an important observation for a lipid-based diet (Berrougui et al., 2003). In 2004, an epidemiologic study carried on sixty-two persons confirmed the hypolipemiant effect of argan oil on humans and allowed the first observation of a decrease in the plasma lipoperoxide level reflecting the in vivo anti-oxidant properties of argan oil (Drissi et al., 2004). Improvement in endothelial dysfunction was also shown to be an additional benefit, strengthening the antihypertensive property of argan oil in spontaneously hypertensive rats, at a daily dose of 10 ml/Kg (Berrougui et al., 2004). The triglyceride-lowering effect of argan oil in humans has been evidenced during a nutritional intervention reported in 2005 (Derouiche et al., 2005). A comparison of the effects of the daily consumption of 25 g of argan oil versus the same amount of olive oil during 3 weeks, revealed a significant decrease in blood LDL-cholesterol and an increase in HDL-cholesterol for both oils. A decrease in the plasmatic triglyceride level was only observed for argan oil consumers. The observation of a decrease in lipoperoxides and conjugated dienes in argan oil consumers led to the conclusion that the antiatherogenic effect of argan oil is also linked to its antioxidant property (Cherki et al., 2005). In 2006, the antioxidant derivatives were definitively identified as a group of phenolic derivatives since the capacity of the phenolic-extract of argan oil to enhance the cholesterol efflux from human THP-1 macrophages was demonstrated (Berrougui et al., 2006). These cumulative data have led to suggest that argan oil consumption could be used to decrease the cardiovascular risk (Cherki et al., 2006) and this, without marked adverse effects on immune cell function (Benzaria et al., 2006).

Antiproliferative effects induced by argan oil consumption have been studied more recently. In two studies carried out on the unsaponifiable fraction of argan oil, a promising antiproliferative effect has been observed on three human prostatic cell lines (PC3, DU145, and LNCaP). Independently evaluated, sterol, polyphenol, and tocopherol fractions exhibited inhibition values lower than those obtained with 2–methoxyestradiol but still significant. These studies have led to consider argan oil as an interesting source for the development of new strategies for prostate cancer prevention (Drissi et al., 2006; Bennami et al., 2007).

Finally, at a dose of 12.5 μg/ml, the unsaponifiable fraction of argan oil was shown to selectively inhibit insulin-dependent and -independent ERK1/2 activation in hepatoma cells, and the proliferation of HT-1080 fibrosarcoma cell line and invasive variant of canine kidney (MSV-MDDCK-INV) cells. This antiproliferative effect could be mediated by the interruption of signaling cascades at the MEK1/2-ERK1/2 interface (Samane et al., 2006).

Argan Oil Versus Other Oils

Argan oil is singular because of its elevated price. However, analysis of the pharmacological data raises the simple question—Does argan oil contain one or several specific compounds, not found in other dietary oils, that could be responsible for improved pharmacological properties?

A simple way to answer this question is to compare the chemical composition of argan and olive oil. This latter is a well-studied oil with established pharmacological benefits and can consequently be considered as a reference oil.

For comparison purposes, both major and minor compounds have to be considered. Linoleic and oleic acids are the main components of each oil. The numerous biological properties of this latter acid have been recently reviewed (Waterman et al., 2007). Depending on its origin, olive oil can contain up to twice as much oleic acid than argan oil (43% versus 83%). However, almost similar levels (49 versus 55%) cannot be ruled out. Would the impact of oleic acid be one of the important parameters to be included in the benefits of argan oil, the consumption of a double argan oil ration, compared to olive oil, should cover this inaccuracy. Argan oil contains also a high level of linoleic acid (at least of 29%) compared to olive oil that may contain a very low level (3.5%). Linoleic acid possesses several pharmacological properties and diets containing 0.1% of linoleic acid have recently been shown to inhibit colon cancer cell metastasis (Soela et al., 2007; Kim et al., 2003). However, other oils (sunflower, corn, or sesame oils) are linoleic acid rich but are not traditionally considered as having a specific impact on human health. It should also be noted that hydroxy linoleic acid derivatives are suspected to favor atherosclerosis progression (Gniwotta et al., 1997). Hence, high dietary levels of linoleic acid are not necessarily globally beneficial for human health. Consequently, none of these two acids can be considered as fully responsible for the pharmacological activity of argan oil although the hypothesis of a unidentified optimum oleic/linoleic ratio cannot be ruled out yet.

The phenolic compounds contained in argan oil are believed to be mainly responsible for the pharmacological properties of argan oil (Khallouki et al., 2003). This fraction, often erroneously directly assimilated to the unsaponifiable matter, represents 56.3 ppm in argan oil and its chemical composition has been recently reviewed (Charrouf and Guillaume, 2007). Olive oil phenolic compounds are also believed to be essential for its pharmacological properties (Owen et al., 2000b, 2000c). Therefore, it could be very tempting to simply perform a comparative analysis of the phenolic derivatives of each oil. However, it must be kept in mind that the chemical composition of olive oil undergoes large variations and its phenolic fraction does not constitute an exception to the rule. For example, and to consider Greek olive oils only, Koroneiki extra virgin olive oil has a phenol content of 43 ppm whereas the phenol content of Tsounati virgin olive oil is 308 ppm. Consequently, the report of the presence or lack of some minor derivatives in oils cannot necessarily be translated in terms of pharmacological activity. Furthermore, all the phenolic compounds contained in argan oil, as well as other dietary oils, have not been identified yet. Therefore it is very important to distinguish the lack of report of the presence of a given compound from the report of the lacking of a given compound.

For the moment, ubiquitous (poly)phenols (caffeic acid, vanillic acid, ferulic acid, syringic acid, *p*-hydroxybenzoic acid) have been unambiguously identified in both oils (Charrouf and Guillaume, 2007; Menendez et al., 2007). Oleuropein, a derivative whose aglycone strongly decreases breast cancer cell viability (Menendez et al., 2007) is also a minor constituent of both oils (Owen et al., 2000b; Charrouf and Guillaume, 2007). Conversely, pinoresinol, a pharmacologically relevant compound found in some olive oils (Fini et al., 2008), has not been identified in argan oil yet.

The main difference between the minor constituents of olive and argan oils is the tocopherol level. Argan oil contains between 600 and 900 mg/kg of tocopherol whereas olive oil contains only 300 mg/kg. Even more importantly, γ-tocopherol is the major component in argan oil tocopherols while α-tocopherol is the major one in olive oil. Tocopherols(α- and γ-) belong to the vitamin E group and display strong and specific pharmacological properties. Since γ-tocopherol impairs α-tocopherol absorption (Reboul et al., 2007a) different activities can be expected from α- or γ-tocopherol rich foods. Also, γ-tocopherol has been shown to be more efficient than α-tocopherol at inhibiting proliferation of prostate cancer cells (LNCap and PC-3) and lung cancer (A549) in vitro at a 50 μM concentration (Jiang et al., 2004). γ-Tocopherol also inhibits cyclooxygenase and possibly lipoxygenase more strongly than α-tocopherol (Reiter et al., 2007). These two tocopherols may also have biological properties unrelated to the antioxidant activity (Reiter et al., 2007). Consequently, γ-tocopherol consumption has been recommended and is associated with a reduced risk of clinically relevant diseases (Wright et al., 2007). Obviously, these

biological properties are in line with the biological effects observed for argan oil. In addition, γ-tocopherol is an efficient agent for the reduction of photo-inflammation in skin (Yoshida et al., 2006) and photoprotection (Konger, 2006). This could explain the specific cosmetic use of argan oil, the presence of caffeic and ferulic acids, two efficient photoprotective agents (Saija et al., 2000) found in most vegetable oils being insufficient to explain it.

Phytosterols are another important group of molecules to consider when searching for healthy diets (Moghadasian, 2000; Ostlund, 2007; Hovenkamp et al., 2008). These derivatives possess anti-atherogenic effects (Moghadasian, 2000). One hundred grams of argan and olive oils contain between 150 and 250 mg of sterols (Hilali et al., 2005; Haddada et al., 2007).Four main sterols (stigmasta-8,22-diene-3-ol, spinasterol, schottenol, and stigmasta, 7-24-diene-3-ol) compose argan oil sterol fraction. Campesterol, a common phytosterol, has been clearly identified as a very minor component in argan oil (Hilali et al., 2005).Sterol diversity is much larger in olive oil where β-sitosterol, 5-avenasterol, and campesterol are the dominant phytosterols and cholesterol, brassicasterol, stigmasterol, clerosterol, sitosterol, Δ-7-stigmasterol, and Δ-7-avenasterol are found in lower quantity (Cunha et al., 2006).The possible influence of each of the different sterols on human health is poorly documented but it has been shown that the association of sterols and long chain (C-18) triglycerides was not necessarily optimum for cardiovascular protection (St-Onge et al., 2003).

CONCLUSION

In conclusion, the high level of γ-tocopherol in argan oil appears to be an essential factor in explaining the benefits of the amazigh diet. However, the bioactivity of functional food is often the result of a synergistic effect between its minor components, and so is not related to one specific constituent (Russo et al., 2007).Whereas neither the amazigh or cretan diets should be considered as the miracle diet to cure globesity (the global epidemic of overweight and obesity), a daily consumption of argan oil is highly likely to be one factor strongly favoring the prevention of urogenital and digestive cancers as well as obesity and cardiovascular diseases. A nutritional comparison of the respective benefits of the cretan and amazigh diets should also be highly valuable to identify the key components of these two diets.

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