ORIGINAL RESEARCH

The effect of dietary and/or cosmetic argan oil on postmenopausal skin elasticity

Kenza Qiraouani Boucetta[1]
Zoubida Charrouf[2]
Hassan Aguenaou[3]
Abdelfattah Derouiche[4]
Yahya Bensouda[1]

[1]Research Team on Formulation and Biopharmacy, Research Center for Drug, Faculty of Medicine and Pharmacy, Mohammed V University, Rabat, Morocco; [2]Faculty of Sciences, Mohammed V University, Rabat, Morocco; [3]Mixed Unit of Research in Nutrition, ITU / CNESTEN, Ibn Tofail University, Kenitra, Morocco; [4]Faculty of Sciences, Hassan II University, Casablanca, Morocco

Correspondence: Yahya Bensouda
Research Team on Formulation and Biopharmacy, Faculty of Medicine and Pharmacy of Rabat University Mohammed V at Souissi, PO Box 6203, Morocco
Tel +212 6 61 33 29 91
Fax +212 5 37 77 37 01
Email y.bensouda@um5s.net.ma

Background: During menopause, the decrease of estrogenic secretion induces the disruption of skin functioning, thus causing the decline in skin elasticity characteristic of skin aging. The purpose of this study was to evaluate in postmenopausal women the effect of daily consumption and/or application of argan oil on skin elasticity.

Materials and methods: Sixty postmenopausal women consumed butter during the stabilization period and were randomly divided into two groups for the intervention period: the treatment group of 30 participants received dietary argan oil, the control group of 30 participants received olive oil, and both groups applied cosmetic argan oil in the left volar forearm during a 60-day period. Assessments of skin elasticity parameters, ie, the three R-parameters (R2 or gross-elasticity of the skin, R5 or net elasticity of the skin, and R7 or biological elasticity), and the resonance running time (RRT) at both volar forearms of the two groups were performed during three visits: before starting oils consumption and application, after 30 days of oils consumption and application, and after 60 days of oils consumption and application.

Results: The consumption of argan oil led to a significant increase of gross-elasticity of the skin (R2) ($P<0.001$), net elasticity of the skin (R5) ($P<0.001$), biological elasticity (R7) ($P<0.001$), and a significant decrease of RRT ($P=0.002$). The application of argan oil led to a significant increase of gross-elasticity of the skin (R2) ($P<0.001$), net elasticity of the skin (R5) ($P<0.001$), biological elasticity (R7) ($P=0.001$), and a significant decrease of RRT ($P<0.001$).

Conclusion: Our findings suggest that the daily consumption and/or topical application of argan oil have an anti-aging effect on the skin demonstrated by the improvement of skin elasticity, characterized by an increase of R-parameters (R2, R5, and R7) and a decrease of RRT.

Keywords: postmenopausal women, argan oil, skin elasticity

Introduction

The skin is stratified into two essential superposed layers: the outermost layer or epidermis and the deeper layer or dermis.

The dermis provides a solid support for the epidermis. It is also its feeder layer. It consists mainly of fibroblasts, cells responsible for collagen and elastic fibers synthesis that enter into the extracellular matrix composition.[1]

Elastic fibers are closely linked and interwoven with the collagen fibrils so that they can recoil after transient stretching, preventing overstretching.

The presence of collagen and elastic fibers or the major (97.5%) and the minor (2.5%) compounds of dermis, respectively, promote the maintenance of resilience and elastic appearance of the skin.[2]

The decrease of estrogenic secretion observed during menopause negatively affects the skin elasticity by a decrease of dermal fibroblasts collagen[3] and elastic

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fibers,[4] characteristic of skin aging;[5] this is the main reason we chose healthy postmenopausal women as the test population for this study.

Treatment with estrogen reverses the changes of collagen and elastic fibers,[6,7] which favor the improvement of skin elasticity in postmenopausal women.[8] But the long-term use of estrogen in the form of hormone replacement therapy triggers many pathophysiological events.[9]

The consumption of dietary argan oil has proved to have a positive effect in the prevention of certain diseases (high cholesterol,[10] heart disease,[11] diabetes,[12] etc) that are known to have a high incidence in postmenopausal women[13] and which may thus be beneficial in treating reduced skin elasticity during menopause.

Although argan oil has a long history in traditional cosmetic use, to maintain the health of skin,[14] its effect on skin elasticity has never been scientifically reported. Therefore, we have attempted to elucidate the effect of argan oil on skin elasticity.

The purpose of this study was to evaluate in postmenopausal women the effect of daily consumption and topical application of argan oil on skin elasticity, as measured by the skin's biomechanical properties that are represented by R-parameters (R2 or gross-elasticity of the skin, R5 or net elasticity of the skin, and R7 or biological elasticity), and resonance running time (RRT) using noninvasive biophysical methods.

Materials and methods
Participants
One hundred postmenopausal women were recruited in our study; 60 of them met the following criteria:

Inclusion criteria: menopause confirmed by dosages of estradiol and follicle-stimulating hormone (estradiol <30 pg/mL and follicle-stimulating hormone >40 IU/L) and absence of skin diseases.

Exclusion criteria: taking a hormone replacement therapy, and use of moisturizing and anti-aging products and dietary supplements.

The 60 postmenopausal women selected gave their informed consent and the study was approved by the Ethical Committee for Biomedical Research of the Faculty of Medicine and Pharmacy, University Mohammed V Rabat, Morocco.

Products
The following products were used in this study: butter, olive oil of the Moroccan Picholine, and dietary and cosmetic argan oil provided by the cooperative Targante with the ECOCERT label.

Study protocol
In this study, there were two diet periods (Figure 1). In diet period 1 (baseline diet), all of the participants consumed 25 g/day of the same brand of butter for 2 weeks to stabilize the lipid profile.[15] In diet period 2, the 60 participants were randomly assigned to the two following diet groups using the "Data – Select cases – Random sample of cases" procedure in SPSS (version 10, IBM Corporation, Armonk, NY, USA): one group of 30 participants, in which 25 g/day butter was substituted by 25 mL/day of argan oil, and the second group of 30 participants consuming 25 mL/day of olive oil as a control during a 60-day period. In parallel, the two groups were asked to apply every night about 240 mg (2 mg/cm²) of cosmetic argan oil, corresponding to 10 drops, on the left volar forearm (LF) and were forbidden to use any other skin care or cosmetic products on their volar forearms throughout the study.

Cosmetic argan oil and alimentary argan and olive oil bottles were delivered to participants every 30 days by the research staff, in order to meet the participants and ensure their adherence to the study. The residual alimentary and cosmetic oil bottles were collected at the time of the next delivery in order to check the adherence of the participants to the allocated treatment. Olive oil was deliberately chosen as the oil of the control group to ensure adherence to the study of women not receiving argan oil, as olive oil is also considered an oil with noble nutritional virtues and widely known for its beneficial health effects.

In the two groups, assessments of skin elasticity, ie, the R-parameters (R2, R5, and R7), and the RRT at the right volar forearm (RF) and the LF were performed in the morning during three visits: before starting oil consumption and application (D0), after 30 days of oil consumption and application (D30), and after 60 days of oil consumption and application (D60).

Bioengineering methods
The measurements of skin elasticity were performed with a Cutometer SEM 575® and a Reviscometer RVM 600®, which were mounted on a Multi Probe Adapter® MPA5 (Courage and Khazaka Electronic GmbH, Cologne, Germany).

The Cutometer SEM 575 with a 2 mm diameter probe is an electronic instrument that assesses biomechanical properties of the skin based on the suction and elongation measuring principle. The time/strain mode (mode 1) was
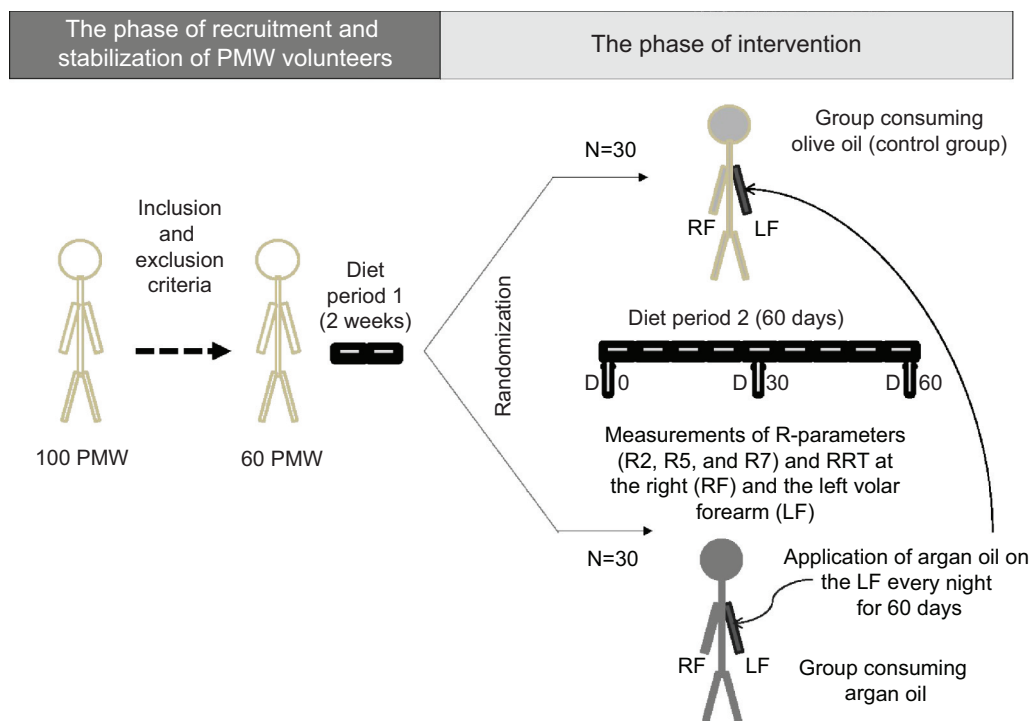
Figure 1 Overall protocol of the study.
Abbreviations: D0, before starting oil consumption and application; D30, after 30 days of oil consumption and application; D60, after 60 days of oil consumption and application; LF, left volar forearm; PMW, postmenopausal women; R2, gross-elasticity of the skin; R5, net elasticity of the skin; R7, biological elasticity; RF, right volar forearm; RRT, resonance running time.

used with ten consecutive cycles of a 2-second application of a constant negative pressure of 450 mbar, followed by a 2-second relaxation period.

A typical skin deformation curve is illustrated in Figure 2 and the following parameters were analyzed: (R2) Ua (the ability of redeformation of skin)/Uf (final distension [skin distensibility]), gross-elasticity of the skin, including viscous deformation;[16] (R5) Ur (immediate retraction)/Ue (immediate
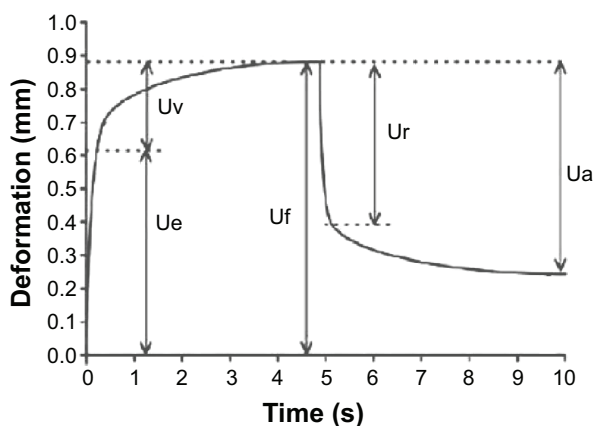
Figure 2 Skin deformation curve obtained with Cutometer.
Abbreviations: Ua, the ability of redeformation of skin; Ue, immediate distension; Uf, final distension (skin distensibility); Ur, immediate retraction; Uv, delayed distension; s, seconds.

distension), net elasticity of the skin without viscous deformation;[16] (R7) Ur/Uf, biological elasticity, ie the ratio of immediate retraction to final distension.[16] The Reviscometer RVM 600 also allows for the evaluation of the mechanical properties of skin by measuring the propagation time of a shear wave between two sensors placed on the skin surface: one is transmitting an acoustical shockwave, and the other is the receiver. The time the wave needs to propagate from transmitter to recipient is the measured parameter that is defined as RRT. It has been shown that RRT is inversely related to skin elasticity.[17] The longer the time the waves need to propagate through the material, the higher the measuring value and the less elastic the material. We measured RRT according to manufacturer instructions.

Statistical analysis

All values are expressed as mean ± standard deviation (SD). R-parameters (R2, R5, and R7), RRT values, and other variables were normally distributed as assessed by the Kolmogorov–Smirnov test.

The parametric test, analysis of variance (ANOVA) for repeated measures, was applied for comparisons of the three paired means (± SD) of R2, R5, R7, and RRT (taken at D0, D30, and D60) of the two volar forearms (RF and LF) of each

Table 1 Baseline demographic and clinical characteristics of the argan and olive groups

Item	Olive group (control)	Argan group
n	30	30
Age, years	55.13±6.45	55.84±5.91
Body weight, kg	70.02±12.27	69.94±11.85
Height, m	1.58±0.06	1.57±0.05
TC, g/L	2.10±0.33	2.13±0.35
LDL-C, g/L	1.30±0.31	1.34±0.31
HDL-C, g/L	0.58±0.12	0.58±0.15
TG, g/L	1.10±0.56	1.09±0.51

Notes: All values are presented as unadjusted mean ± standard deviation.
Abbreviations: LDL-C, low-density lipoprotein cholesterol; HDL-C, high-density lipoprotein cholesterol; TC, total cholesterol; TG, triglycerides.

group (argan and olive). When the ANOVA test for repeated measures was significant, the Bonferroni test was applied to perform post hoc pairwise multiple comparisons within the three paired means (± SD) of R2, R5, R7, and RRT.

The Student's t-test for independent samples was used to compare the mean of the R2, R5, R7, and RRT between

the two forearms of each group at the beginning of the study (at D0) to prove the homogeneity of the results and at the end of the study (at D60) to support the results of the ANOVA for repeated measures.

Differences were considered to be statistically significant at $P<0.05$ and the statistical software SPSS version 10.0 was used.

Results

Baseline demographic and clinical characteristics of participants treated with argan and olive oil in both groups are shown in Table 1.

Results of the untreated forearm or RF

In the group consuming argan oil, the paired means (± SD) of R-parameters (R2, R5, and R7) and RRT values as a function of time (D0, D30, and D60) showed a statistically significant difference (at the $P<0.05$ level) between at least two means (± SDs) of R-parameters (Figure 3A, Figure 4A,
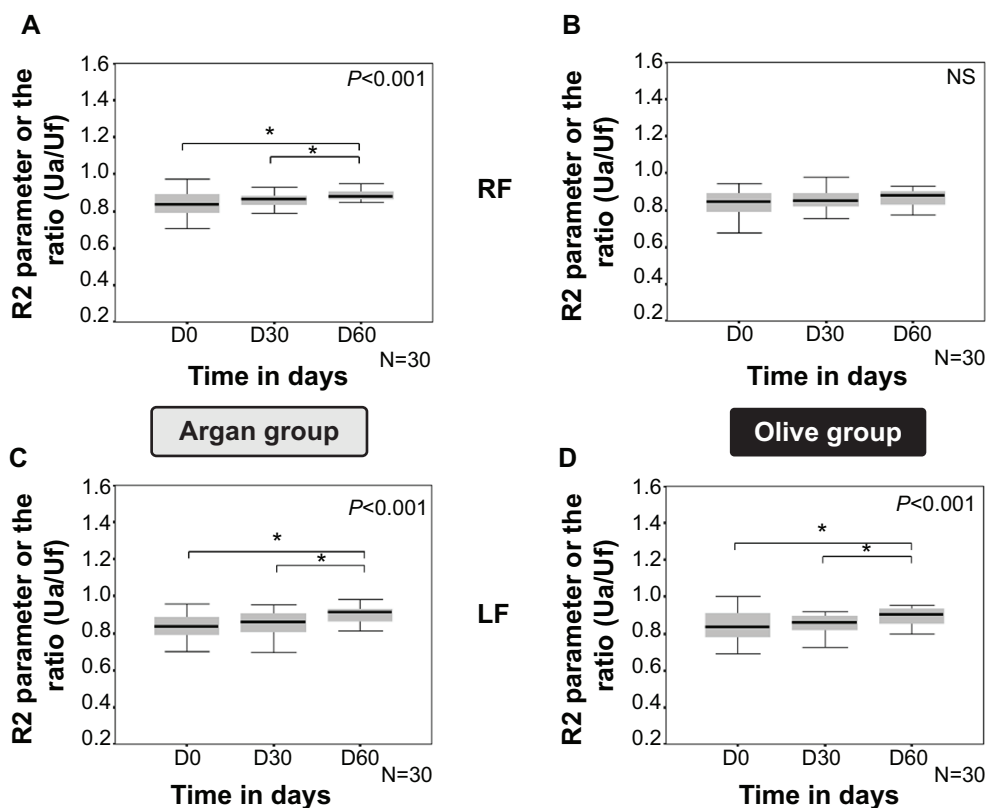
Figure 3 Volar forearm R2 (gross-elasticity of the skin) evolution.
Notes: Evolution after oils consumption and/or argan oil application at (**A**) the RF in the group consuming argan oil, (**B**) the RF in the group consuming olive oil, (**C**) the LF in the group consuming argan oil, and (**D**) the LF in the group consuming olive oil. The difference between the three paired means (± SD) of R2 (taken at D0, D30, and D60) of the two volar forearms (RF and LF) of each group (argan and olive) was analyzed using the ANOVA test for repeated measures followed by the Bonferroni post hoc test (if the ANOVA test for repeated measures was statistically significant). $P<0.05$ was considered statistically significant (for the results of the ANOVA test for repeated measures). NS: ANOVA test for repeated measures showed no statistically significant difference ($P>0.05$). *$P<0.05$ was considered statistically significant (for the results of the Bonferroni post hoc test).
Abbreviations: ANOVA, analysis of variance; D0, before starting oil consumption and application; D30, after 30 days of oil consumption and application; D60, after 60 days of oil consumption and application; LF, left volar forearm; NS, no significant difference; RF, right volar forearm; SD, standard deviation; Ua/Uf, gross-elasticity of the skin, including viscous deformation.
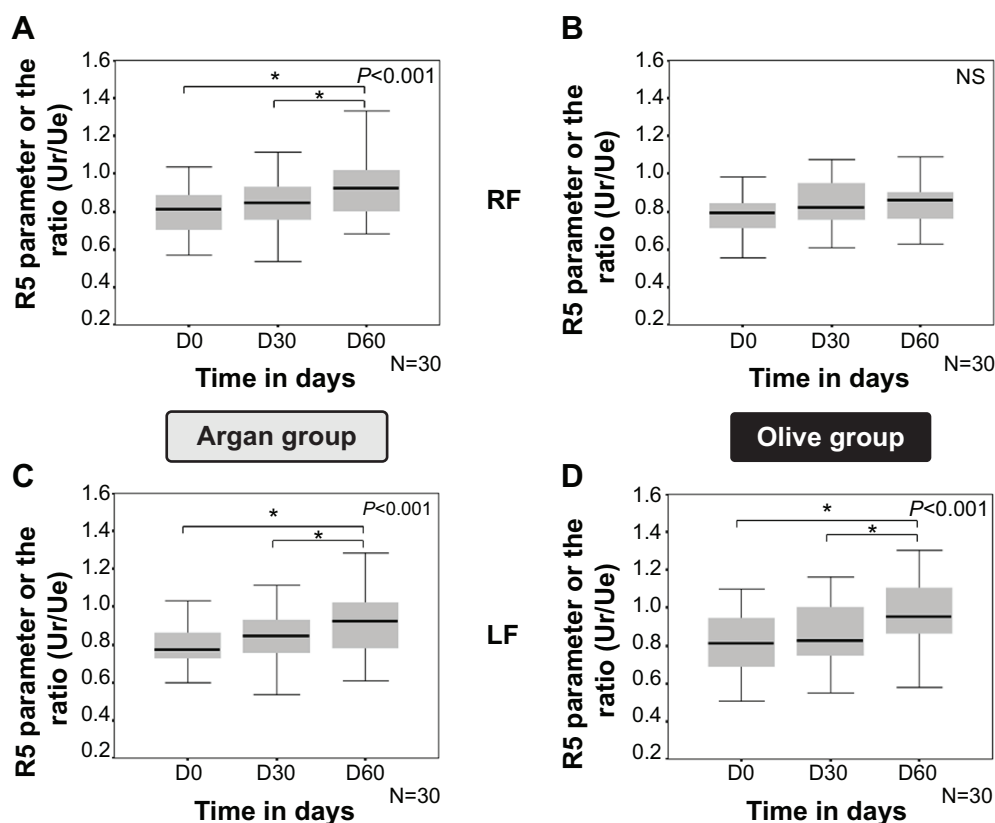
Figure 4 Volar forearm R5 (net elasticity of the skin without viscous deformation) evolution.
Notes: Evolution after oils consumption and/or argan oil application at (**A**) the RF in the group consuming argan oil, (**B**) the RF in the group consuming olive oil, (**C**) the LF in the group consuming argan oil, and (**D**) the LF in the group consuming olive oil. The difference between the three paired means (± SD) of R5 (taken at D0, D30, and D60) of the two volar forearms (RF and LF) of each group (argan and olive) was analyzed using the ANOVA test for repeated measures followed by the Bonferroni post hoc test (if the ANOVA test for repeated measures was statistically significant). $P<0.05$ was considered statistically significant (for the results of the ANOVA test for repeated measures). NS: the ANOVA test for repeated measures showed no statistically significant difference ($P>0.05$). *$P<0.05$ was considered statistically significant (for the results of the Bonferroni post hoc test).
Abbreviations: ANOVA, analysis of variance; D0, before starting oil consumption and application; D30, after 30 days of oil consumption and application; D60, after 60 days of oil consumption and application; LF, left volar forearm; NS, no significant difference; RF, right volar forearm; SD, standard deviation; Ur/Ue, net elasticity of the skin without viscous deformation.

and Figure 5A) and RRT (Figure 6A) with a level of significance of $P<0.001$ and $P=0.002$, respectively. This statistically significant difference existed between the D0 and the D60 mean (± SD) for R2 ($P=0.001$; Figure 3A), R5 ($P<0.001$; Figure 4A), R7 ($P<0.001$; Figure 5A), and RRT ($P=0.002$; Figure 6A) and between the D30 and the D60 mean (± SD) for R2 ($P=0.019$; Figure 3A), R5 ($P=0.006$; Figure 4A), R7 ($P=0.011$; Figure 5A), and RRT ($P=0.001$; Figure 6A). No statistically significant difference was observed between at least two means (± SDs) of R-parameters ($P>0.05$; Figure 3B, Figure 4B, and Figure 5B) and RRT values ($P>0.05$; Figure 6B) in the group consuming olive oil.

Between the group consuming argan oil and that consuming olive oil, there was no statistically significant difference in the unpaired means (± SD) of the means (± SD) of R-parameters ($P>0.05$) and RRT ($P>0.05$) at baseline (D0), but there was a statistically significant difference after the

60-day period (D60) in favor of the group consuming argan oil for the R2 ($P=0.036$), R5 ($P=0.036$), R7 ($P=0.012$), and RRT values ($P=0.006$) (Table 2).

Results of the treated forearm or LF

The paired means (± SD) of R-parameters (R2, R5, and R7) and RRT values as a function of time (D0, D30, and D60) showed a statistically significant difference between at least two means (± SDs) of R2, R5, R7, and RRT with a level of significance of $P<0.001$, $P<0.001$, $P=0.001$ (Figure 3C, Figure 4C, and Figure 5C), and $P<0.001$ (Figure 6C), respectively, in the group consuming argan oil, and with a level of significance of $P<0.001$ (Figure 3D, Figure 4D, Figure 5D) and $P=0.008$ (Figure 6D), respectively, in the group consuming olive oil. This statistically significant difference existed between the D0 and the D60 means (± SD) for R2 ($P<0.001$ in the two groups; Figure 3C, D), R5 ($P=0.006$ in the group consuming argan oil and $P<0.001$ in
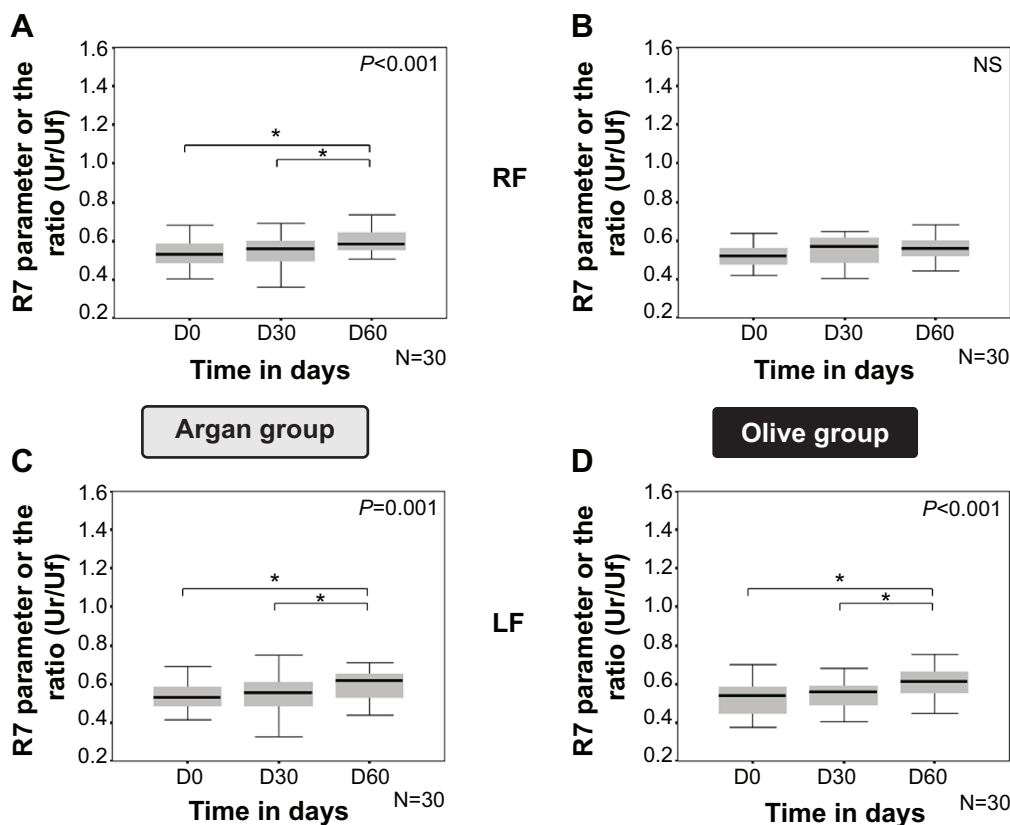
Figure 5 Volar forearm R7 (biological elasticity) evolution.

Notes: Evolution after oils consumption and/or argan oil application at (**A**) the RF in the group consuming argan oil, (**B**) the RF in the group consuming olive oil, (**C**) the LF in the group consuming argan oil, and (**D**) the LF in the group consuming olive oil. The difference between the three paired means (± SD) of R7 (taken at D0, D30, and D60) of the two volar forearms (RF and LF) of each group (argan and olive) was analyzed using the ANOVA test for repeated measures followed by the Bonferroni post hoc test (if the ANOVA test for repeated measures was statistically significant). $P<0.05$ was considered statistically significant (for the results of the ANOVA test for repeated measures). NS: the ANOVA test for repeated measures showed no statistically significant difference ($P>0.05$). *$P<0.05$ was considered statistically significant (for the results of the Bonferroni post hoc test).

Abbreviations: ANOVA, analysis of variance; D0, before starting oil consumption and application; D30, after 30 days of oil consumption and application; D60, after 60 days of oil consumption and application; LF, left volar forearm; NS, no significant difference; RF, right volar forearm; SD, standard deviation; Ur/Uf, biological elasticity, ie, the ratio of immediate retraction to final distension.

the group consuming olive oil; Figure 4C, D), R7 ($P<0.001$ in the two groups; Figure 5C, D), and RRT ($P<0.001$ in the group consuming argan oil and $P=0.022$ in the group consuming olive oil; Figure 6C, D), and between the D30 and the D60 means (± SD) for R2 ($P=0.004$ in the group consuming argan oil and $P=0.002$ in the group consuming olive oil; Figure 3C, D), R5 ($P=0.007$ in the group consuming argan oil and $P=0.001$ in the group consuming olive oil; Figure 4C, D), R7 ($P=0.010$ in the group consuming argan oil and $P<0.001$ in the group consuming olive oil; Figure 5C, D), and RRT ($P=0.001$ in the group consuming argan oil and $P=0.022$ in the group consuming olive oil; Figure 6C, D).
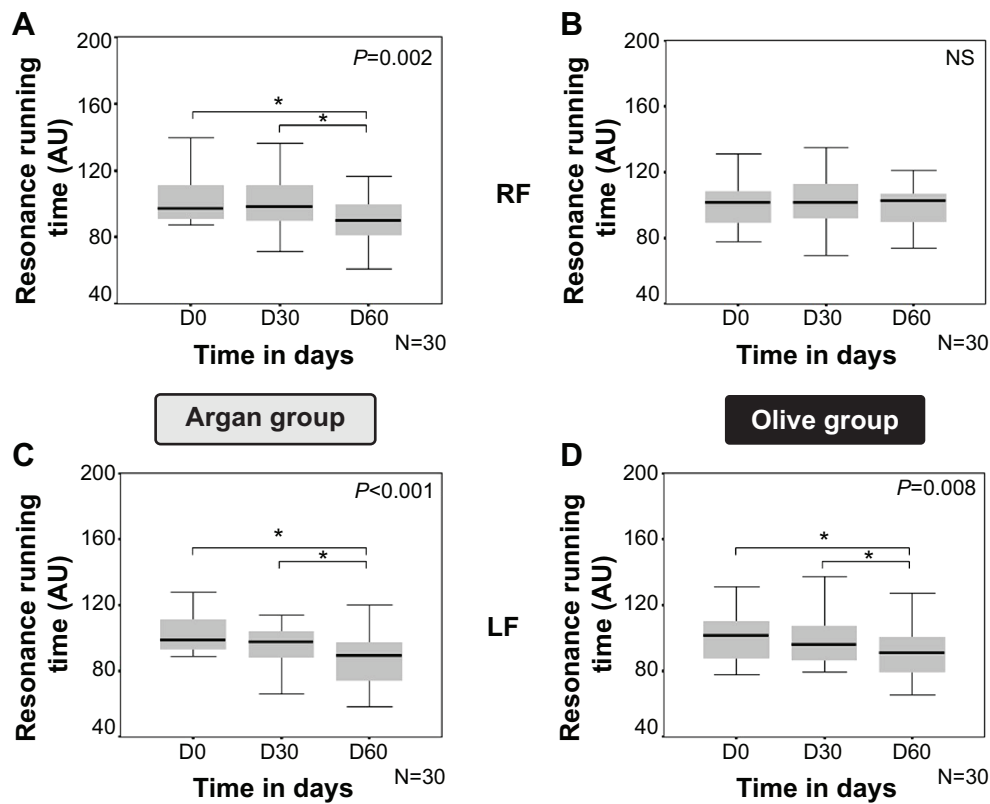
Between the group consuming argan oil and that consuming olive oil, there was no statistically significant difference in the unpaired means (± SD) of R-parameters ($P>0.05$) and RRT values ($P>0.05$) at baseline (D0) and after the 60-day period (D60) (Table 2).

Comparison of topical-argan-oil-treated and -untreated forearms, or LF and RF, in the two groups

Between the RF and the LF in the two groups (argan and olive), there was no statistically significant difference in the unpaired means (± SD) of R-parameters ($P>0.05$) and the RRT ($P>0.05$) at baseline (D0), but there was a statistically significant difference after the 60-day period (D60) in favor of the LF in the group consuming olive oil with $P=0.023$, $P=0.004$, $P=0.005$, and $P=0.022$ for the R2, R5, R7, and RRT values, respectively (Table 3).

Discussion

In this study we have demonstrated that the daily consumption and topical application of argan oil improves skin elasticity by increasing the R-parameters (R2, R5, and R7) and decreasing the RRT in postmenopausal women after a period of 60 days.

Figure 6 Volar forearm RRT evolution.
Notes: Evolution after oils consumption and/or argan oil application at (**A**) the RF in the group consuming argan oil, (**B**) the RF in the group consuming olive oil, (**C**) the LF in the group consuming argan oil, (**D**) the LF in the group consuming olive oil. The difference between the three paired means (± SD) of RRT (taken at D0, D30, and D60) of the two volar forearms (RF and LF) of each group (argan and olive) was analyzed using the ANOVA test for repeated measures followed by the Bonferroni post hoc test (if the ANOVA test for repeated measures was statistically significant). $P<0.05$ was considered statistically significant (for the results of the ANOVA test for repeated measures). NS: the ANOVA test for repeated measures showed no statistically significant difference ($P>0.05$). *$P<0.05$ was considered statistically significant (for the results of the Bonferroni post hoc test).
Abbreviations: ANOVA, analysis of variance; AU, arbitrary units; D0, before starting oil consumption and application; D30, after 30 days of oil consumption and application; D60, after 60 days of oil consumption and application; LF, left volar forearm; NS, no significant difference; RF, right volar forearm; RRT, resonance running time; SD, standard deviation.

Table 2 The intergroup comparison of R-parameters (R2, R5, and R7) and resonance running time of the volar forearm between the two groups before (D0) and after 60 days (D60) of oils consumption and/or argan oil application

			Olive group N=30	Argan group N=30	*P*-value
R2 parameter or the ratio (Ua/Uf)	RF	D0	0.836±0.067	0.838±0.077	>0.05
		D60	0.855±0.072	0.886±0.029	0.036
	LF	D0	0.836±0.083	0.837±0.063	>0.05
		D60	0.893±0.049	0.895±0.048	>0.05
R5 parameter or the ratio (Ur/Ue)	RF	D0	0.793±0.12	0.798±0.12	>0.05
		D60	0.850±0.144	0.940±0.188	0.036
	LF	D0	0.797±0.16	0.801±0.103	>0.05
		D60	0.993±0.218	0.937±0.192	>0.05
R7 parameter or the ratio (Ur/Uf)	RF	D0	0.525±0.058	0.531±0.086	>0.05
		D60	0.551±0.074	0.594±0.059	0.012
	LF	D0	0.525±0.085	0.533±0.064	>0.05
		D60	0.607±0.075	0.595±0.079	>0.05
Resonance running time (AU)	RF	D0	102.1±15.26	103.70±17.24	>0.05
		D60	99.48±11.98	90.23±12.95	0.006
	LF	D0	101.59±15.78	104.76±16.73	>0.05
		D60	91.29±14.82	87.09±14.33	>0.05

Notes: All values are presented as mean ± standard deviation. Mean group comparisons were conducted using Student's *t*-test for independent samples. $P<0.05$ was considered statistically significant.
Abbreviations: AU, arbitrary units; LF, left volar forearm; R2, Ua/Uf, gross-elasticity of the skin, including viscous deformation; R5, Ur/Ue, net elasticity of the skin without viscous deformation; R7, Ur/Uf, biological elasticity, ie, the ratio of immediate retraction to final distension; RF, right volar forearm.

Table 3 The intergroup comparison of R-parameters (R2, R5, and R7) and resonance running time between the two volar forearms (RF and LF) before (D0) and after 60 days (D60) of oils consumption and/or argan oil application in the two groups

			RF	LF	*P*-value
R2 parameter or the ratio (Ua/Uf)	Argan group N=30	D0	0.838±0.077	0.837±0.063	>0.05
		D60	0.886±0.029	0.895±0.048	>0.05
	Olive group N=30	D0	0.836±0.067	0.836±0.083	>0.05
		D60	0.855±0.072	0.893±0.049	0.023
R5 parameter or the ratio (Ur/Ue)	Argan group N=30	D0	0.798±0.12	0.801±0.103	>0.05
		D60	0.940±0.188	0.937±0.192	>0.05
	Olive group N=30	D0	0.793±0.12	0.797±0.16	>0.05
		D60	0.850±0.144	0.993±0.218	0.004
R7 parameter or the ratio (Ur/Uf)	Argan group N=30	D0	0.531±0.086	0.533±0.064	>0.05
		D60	0.594±0.059	0.595±0.079	>0.05
	Olive group N=30	D0	0.525±0.058	0.525±0.085	>0.05
		D60	0.551±0.074	0.607±0.075	0.005
Resonance running time (AU)	Argan group N=30	D0	103.70±17.24	104.76±16.73	>0.05
		D60	90.23±12.95	87.09±14.33	>0.05
	Olive group N=30	D0	102.1±15.26	101.59±15.78	>0.05
		D60	99.48±11.98	91.29±14.82	0.022

Notes: All values are presented as mean ± standard deviation. Mean group comparisons were conducted using Student's *t*-test for independent samples. *P*<0.05 was considered statistically significant.
Abbreviations: AU, arbitrary units; LF, left volar forearm; R2, Ua/Uf, gross-elasticity of the skin, including viscous deformation; R5, Ur/Ue, net elasticity of the skin without viscous deformation; R7, Ur/Uf, biological elasticity, ie, the ratio of immediate retraction to final distension; RF, right volar forearm.

In postmenopausal women, the decline in endogenous estrogen levels negatively affects skin elasticity, which causes a loss of skin collagen of up to 30% during the first 5 years after menopause[3,18,19] or an average decline of 2.1% per postmenopausal year over 15 years.[18] This also leads to the acceleration of degenerative changes in dermal elastic fibers,[4] thus favoring the acceleration of skin aging.

This loss of collagen and elastic fibers may be the result of two mechanisms: the synthesis decrease and the degradation increase of collagen and elastic fibers. The decrease of collagen and elastic fibers synthesis would be due to the influence of hypoestrogenism on the synthesis of transforming growth factor-beta (TGFβ),[20] a cytokine involved in the activation of collagen and elastic fibers production via the signaling pathway.[21] The increase of collagen and elastic fibers degradation would be due to the increase of reactive oxygen species (ROS) caused by the decrease of estrogen, representing the antioxidant of the human body, which induces an imbalance between the production of ROS and antioxidative defense observed at menopause,[22] favoring the activation of matrix metalloproteinases (MMPs),[23] a family of zinc-containing proteinases that have the ability to degrade collagen and elastic fibers.[24]

Estrogen treatment has improved skin elasticity by increasing collagen and elastic fibers synthesis, resulting from a decrease of TGFβ, as well as by decreasing collagen and elastic fibers degradation, resulting from a decrease of MMPs.

This shows that estrogen treatment has a beneficial effect on reversing skin aging signs and maintaining skin elasticity in postmenopausal women,[25] but its long-term use in the form of hormone replacement therapy triggers many pathophysiological events.[9]

The measurements of R-parameters have widely been used for determining biomechanical properties of human skin. The following R-parameters are known indicators of skin elasticity:[26] R2 is a measure of the gross elasticity of the skin, including viscous deformation, and is represented by the ratio of "the ability of redeformation of skin" to "final distension," ie, Ua/Uf,[16] or it is also known as the overall elasticity of the skin including creep and creep recovery.[27] R5 is the so-called net elasticity of skin without viscous deformation. Elastic recovery is represented by the ratio of "immediate retraction" to "immediate distension," ie, Ur/Ue.[16] R7 is referred to as biological elasticity. This parameter relates elasticity with final distension. It is represented by the ratio of "immediate retraction" to "final distension," ie, Ur/Uf.[16]

In addition to the above measurements, skin elasticity measurements were also paralleled and confirmed by the RRT, measurements that represent the propagation time of a shear wave between two sensors placed on the skin surface; it has been shown that RRT is inversely related to skin elasticity.[17]

In this study, the results of the RF comparison showed an improvement in skin elasticity after 60 days of dietary

argan oil consumption, which was demonstrated by a statistically significant increase of R-parameters (R2, R5, and R7), since the closer the values are to 1 (100%), the more elastic the skin is.[28] These increased R-parameters (R2, R5, and R7) were related to the increase of the content of collagen and elastic fibers of the skin, which agrees with the study by Ryu et al in which R2, R5, and R7 were negatively correlated to skin aging,[29] characterized by the decrease of collagen and elastic fibers. In addition, these results of R-parameters were also confirmed by the statistically significant decrease of RRT, since the higher the measuring value, the less elastic the skin is,[30] while no statistically significant improvement in skin elasticity was provided after the consumption of olive oil. As well, the comparison of the RF between the two groups at D60 showed a statistically significant improvement in skin elasticity in favor of the group consuming argan oil after the 60 days of consumption. In addition, in both groups, the results of the LF comparison showed a statistically significant improvement in skin elasticity after the 60 days of oils treatment. In the group consuming argan oil, these results of the LF reflected the more synergetic effect of the consumption and the application of argan oil; while in the group consuming olive oil, the results of the LF were due only to the effect of argan oil application, since the consumption of olive oil made no statistically significant improvement on RF. These results are due to the more abundant content of antioxidants in argan oil than that observed in olive oil. These antioxidants are mainly tocopherols (vitamin E), in addition to polyphenols, especially phenolic acid (ferulic acid).[31–35] Vitamin E is a lipid-soluble nutrient that is derived from dietary intake of vegetable oils such as olive and argan oils. In addition to its antioxidant properties,[36] vitamin E can act on skin elasticity by the downregulation of TGFβ,[37] resulting in a signal inducing fibroblasts to produce more collagen and elastic fibers necessary for the normal appearance and integrity of skin. Treatment with argan oil has increased the level of vitamin E in postmenopausal women's blood more than treatment with olive oil,[38] which can explain the improvement of skin elasticity with argan oil treatment found in our study results. Ferulic acid is a phenolic compound found in argan and olive oil for some authors,[33] and absent in olive oil composition for the others,[34,35] known by its antioxidant properties.[39] In Japan it has been approved as a food additive to prevent oxidation[40] through its capacity to stay in the blood for longer than other antioxidants[41] and favoring the neutralization of ROS.

The synergistic antioxidant effect of vitamin E and ferulic acid plays a key role in the maintenance of skin elasticity[42,43]

through the decline in collagen and elastic fibers degradation in response to MMP inhibition activity. That may help to protect postmenopausal women against the high levels of ROS implied in the acceleration of skin aging that takes place in age-related estrogen loss.[22]

So, vitamin E, synergistically with the ferulic acid present in argan oil, can replace the role of estrogen in the prevention of skin aging through the maintenance of skin elasticity in postmenopausal women.

This study has some limitations. One is the short duration of the intervention (60 days); the extension of this period was not possible, since most of the volunteers had other commitments. In addition to the inclusion of tocopherols and other argan oil chemical components (free fatty acid, phenol, and other compounds) are present in olive oil, with the exception of two essential sterols (schottenol and spinasterol), syringic acid, which have no known effects on skin elasticity , and phenolic acids (ferulic acid).[31–35]

Despite these limitations, this study shows a favorable trend of the efficiency of argan oil on skin elasticity of postmenopausal women and provides a good preliminary to a larger study. As well, no side effects were noted with the studied oil treatments during the study period. In addition, our population has probably benefited from the positive effect of argan oil in the prevention of disruptions or diseases related to menopause.[13] Some of these effects (lipid and hormone profiles) are simultaneously being investigated by the other members of the research team.

Conclusion

The consumption and/or application of dietary and cosmetic argan oil, respectively, showed an ameliorative effect on skin elasticity of postmenopausal women after a 60-day period.

Acknowledgments

Author contributions

Dr Bensouda had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

All authors contributed toward data analysis, drafting and revising the paper and agree to be accountable for all aspects of the work.

Disclosure

The authors report no conflicts of interest in this work.

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