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Oleaster Oil Positively Modulates Plasma Lipids in Humans

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ABSTRACT: The olive tree had been domesticated during the early Neolithic in the Near East, and more than 1000 different cultivars have been identified to date. However, examples of wild olive trees (*Olea europaea oleaster*) can still be found in the Mediterranean basin. Evidence of oleaster use for oil production can be found in historical and sacred texts, such as the Odyssey, the Holey Koran, and the Holey Bible. While the nutritional and healthful properties of olive oil are actively being explored, there are no data on the human actions of oleaster oil. Therefore, we investigated the effect of prolonged, i.e., 1 month, consumption of oleaster oil on the lipid profile of a 40 healthy Algerian subjects (aged 27.9 ± 3.85 years), as compared to nonconsumers from the same area. Plasma urea, creatinine, and uric acid concentrations and glycemia did not significantly differ, at the end of the study, between controls and oleaster-oil-supplemented subjects. Conversely, we recorded significant decreases of plasma triglyceride concentration (−24.8%; $p < 0.05$), total cholesterol (−12.13%; $p < 0.05$), and low-density lipoprotein-cholesterol (LDL-C) (−24.39%; $p < 0.05$) in oleaster-oil-treated subjects. Concomitantly, high-density lipoprotein-cholesterol (HDL-C) concentrations were significantly increased (17.94%; $p < 0.05$) by oleaster oil administration. In conclusion, we show that oil obtained from feral olive trees, i.e., oleasters, improves the plasma lipid profile of healthy volunteers.

KEYWORDS: Oleaster, Mediterranean diet, cardiovascular disease, oleic acid, cholesterol

INTRODUCTION

The olive tree had been domesticated during the early Neolithic in the Near East,[1,2] and more than 1000 different cultivars have been identified to date. However, examples of wild olive trees (*Olea europaea oleaster*) can still be found in the central (Corsica, France, and Tunisia), western (Morocco, Algeria, Tunisia, Spain, and France), and eastern (Turkey, Cyprus, and Palestine) Mediterranean basin. In reality, the term "oleaster" encompasses several feral varieties of olive trees. Also called Russian olive or trebizond date (species *Elaeagnus angustifolia*), oleasters are particularly drought-tolerant[3] and produce edible, olive-shaped, yellowish fruits. Evidence of oleaster use for oil production can be found in historical and sacred texts, such as the Odyssey,[4] the Holey Koran,[5] and the Holey Bible.[6] As far as we know, a large proportion of the olive oil produced from oleaster was employed for medicinal, cosmetic, or religious purposes. From a nutritional viewpoint, oleasters oils are interesting, because they produced oils with high amounts of minor compounds (phenols and volatiles), similar to extra virgin olive oils and depending upon the cultivar.[7]

While the nutritional and healthful properties of olive oil are actively being explored,[8] there are no data on the human actions of oleaster oil. Therefore, we investigated the effect of prolonged consumption of oleaster oil on the lipid profile of a group of healthy Algerian subjects, as compared to nonconsumers from the same area.

MATERIALS AND METHODS

Design. Oleaster fruits were collected from Tlemcen's surroundings (west Algeria). Oleaster oil was extracted by traditional procedures, i.e., crushing, malaxation, and pressure of the paste. A single batch was produced and used in this study. Acid value (AV), saponification value (SV), specific gravity (SG), and refractive index (RI) were determined by standard methods.[9] Gas−liquid chromatography was carried out to determine the fatty acid composition of oleaster oil, after conversion of fatty acids into methyl esters. Phenolic compounds were extracted from the oil and were quantified according to the method by Pirisi et al.[10] Analyses are reported in Table 1.

Experimental Procedure. This study conforms to the Declaration of Helsinki: Ethical Principles for Medical Research Involving Human Subjects and was approved by the local ethics committee. A total of 40 healthy subjects (20 men and 20 women) aged 27.9 ± 3.85 years [mean ± standard deviation (SD)] were recruited from within the Abu Bakr Belkaid University (Tlemcen, Algeria) and gave written or oral informed consent to the study. Their mean body mass index was 23.79 ± 1.71 kg/m^2, and their mean diastolic and systolic blood pressures were 76.3 ± 6.6 and 124.4 ± 8.05 mmHg, respectively. All participants were free of metabolic diseases, such as hypercholesterolemia, hypertriglyceridemia, diabetes, or hypertension, and, therefore, did not consume any lipid-modulating drug.

The daily habits of the participants, e.g., physical activity and sleeping and working hours, did not change throughout the study. Subjects were randomly allocated to two study groups: 20 subjects consumed 23 g/day (~2 tablespoons) oleaster oil at breakfast for 4 weeks (consumers group), while 20 did not consume this oil (controls) and maintained their habitual diet. To check for compliance, all subjects were asked

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Table 1. Composition of the Oleaster Oil at Study[a]

AV	4.84
SV	162.9
SG	0.92
RI	1.45
fatty acids (%)	
16:0	9.55
16:1n-7	0.71
18:0	2.69
18:1n-9	74.4
18:1n-7	2.53
18:2	8.7
18:3	0.85
total SFA	12.5
total unsaturates	87.44
total MUFA	77.64
MUFA/PUFA	8.15
polyphenols (mg/kg)	420

[a] AV, acidic value; SV, saponification value; SG, specific gravity; RI, refractive index; SFA, saturated fatty acid; MUFA, monounsaturated fatty acid; PUFA, polyunsaturated fatty acid.

Table 2. Dietary Intakes of Macronutrients of Controls and Oleaster-Oil-Treated Subjects, at T_{30}[a]

nutriments	controls	oleaster oil
energy intake (kJ/day)	10325.56 ± 1015.26	10478.56 ± 1023.47
proteins (g/day)	83.46 ± 14.23	82.41 ± 14.05
proteins (%)	14.46	13.65
carbohydrates (g/day)	340.16 ± 41.56	355.26 ± 45.56
carbohydrates (%)	58.95	58.48
total fat (g/day)	68.15 ± 11.46	73.79 ± 13.85
total fat (%)	26.57	27.50
SFA (%)	39.15 ± 3.14	28.45 ± 1.35[b]
MUFA (%)	31.68 ± 1.46	40.43 ± 3.42[b]
PUFA (%)	29.24 ± 1.69	31.18 ± 2.65

[a] Data are the mean ± SD. At T_0, all subjects had nearly identical diet compositions, which were similar to those reported for controls at T_{30}. Hence, data for controls are means of all subjects. SFA, saturated fatty acid; MUFA, monounsaturated fatty acid; PUFA, polyunsaturated fatty acid. [b] $p < 0.05$ as compared to controls.

about the quality and quantity of food that they consumed during the day before blood sampling. Data were converted into energy and estimated according to the Ciqual standard table of food composition,[11] which is shown in Table 2, using specific software (Regal Plus) that computes the diet composition.

At the beginning (T_0) and at the end (T_{30}) of the intervention, venous blood was collected into ethylenediaminetetraacetic acid (EDTA)-coated tubes, after fasting an overnight fast. Plasma was obtained by centrifugation at 2100*g* for 20 min at 4 °C, and aliquots were stored at −20 °C.

Biochemical Determinations. Plasma glucose was determined by the glucose oxidase method, using a glucose analyzer (Beckman Instruments, Fullerton, CA). Plasma creatinine, urea, and uric acid were measured using enzymatic colorimetric methods (all kits from BioAssay Systems, Hayward, CA). Plasma lipoproteins [low-density lipoprotein (LDL), $d < 1.063$; high-density lipoprotein (HDL), $d < 1.21$ g/mL] were separated by sequential ultracentrifugation. Serum total cholesterol (TC) and triacylglycerol (TG) were measured using enzymatic kits (Quimica Clinica Aplicada S.A., Amposta, Spain). HDL-cholesterol (HDL-C) and LDL-cholesterol (LDL-C) concentrations were also measured by enzymatic kits.

Table 3. Plasma Lipids of Controls and Oleaster-Oil-Supplemented Subjects, at T_{30}[a]

	controls	oleaster oil
total cholesterol (mg/dL)	165 ± 8	145 ± 3[b]
triacylglycerol (mg/dL)	121 ± 5	91 ± 3[b]
LDL-C (mg/dL)	82 ± 4	62 ± 3[b]
LDL-TG (mg/dL)	23 ± 2	19 ± 1
HDL-C (mg/dL)	39 ± 1	46 ± 2[b]
HDL-TG (mg/dL)	11 ± 2	13 ± 1

[a] Data are the mean ± SD. At T_0, all subjects had nearly identical plasma lipid profiles, which was similar to those reported for controls at T_{30}. Hence, data for controls are means of all subjects. LDL, low-density lipoprotein; HDL, high-density lipoprotein; C, cholesterol; TG, triacylglycerol. [b] $p < 0.05$ as compared to controls.

Statistical Analysis. The results are expressed as the mean ± SD. A paired Student's *t* test was used to compare data from the intervention group to those from controls. Statistical analysis was performed using Statistica (version 4.1, Statsoft, Paris, France). A *p* value less than 0.05 was considered statistically significant.

RESULTS AND DISCUSSION

In ancient times, oleaster was exploited, both as a tree and as a source of oil, at the crossroad between religion and medicine. In addition to its putative nutritional and medicinal values, other uses of oleaster imbibed it with symbolic connotations. As an example, its branches were used to form the olive wreath awarded victors at the ancient Olympic Games. Because of its high proportion of monounsaturated fatty acid (MUFA) and polyphenol (certainly unknown to our ancestors), oleaster oil found applications in folk medicine and nutrition. We wanted to explore the effects of oleaster oil on healthy volunteers, by focusing on one facet of cardiovascular risk, namely, their plasma lipid profile.

No side effects were reported by the volunteers. Plasma urea, creatinine, uric acid, and glycemia concentrations did not significantly differ, at the end of the study, between controls and oleaster-oil-supplemented subjects (data not shown). Conversely, we recorded significant decreases of concentrations of plasma triglycerides (−24.8%; $p < 0.05$), total cholesterol (−12.13%; $p < 0.05$), and LDL-C (−24.39%; $p < 0.05$), in oleaster-oil-treated subjects (Table 3). Concomitantly, HDL-C concentrations were significantly increased (17.94%; $p < 0.05$) by oleaster oil administration. The lipid profiles of control subjects did not change significantly at the end of the study. It is noteworthy that, unexpectedly, consumption of olive oil in Algeria is quite low (approximately 1 kg/year), whereas milk consumption is higher than in neighboring Maghreb countries.[12] Hence, we can speculate that the observed improvement in plasma lipids is, at least partially, due to increased MUFA intake and concomitant lower saturated fatty acid (SFA) consumption. The effects of MUFA, namely, oleic acid, on plasma lipids are still controversial. While some authors attribute oleic acid a cholesterol-improving activity, mostly in terms of raising HDL-C and lowering LDL-C, other investigators think otherwise.[13,14] Notably, in 1994, the Food and Drug Administration (FDA) allowed the claim that "limited

and not conclusive scientific evidence suggests that eating about 2 tablespoons (23 grams) of olive oil daily may reduce the risk of coronary heart disease due to the monounsaturated fat in olive oil".[15] This is the amount we gave our volunteers and that resulted in overall increased MUFA intakes at the expense of SFA (Table 2). It is also of note that we recorded a significant increase in plasma HDL-C. Our data fit with evidence from the literature showing HDL-C-raising effects of polyphenol-rich foods, including tea,[16] cocoa,[17] and extra virgin olive oil.[18] Indeed, earlier uses of oleaster oil included cosmetic applications, in which the high polyphenolic content of this oil might have played remarkable roles.[19,20]

Our result largely agrees with one previous study carried out in rats (albeit with oleaster leaves);[21,22] although we did not record any significant modifications of the plasma concentrations of urea, creatinine, uric acid, and glycemia in our volunteers, we do confirm, in humans, the cholesterol-lowering effects of oleaster oil. It is noteworthy that our subjects had low mean cholesterolemia, which reflects the average values found in countryside Algeria and, in general, in this Maghrebian area.[23]

Our study has limitations, most of which are a result of technical constraints, that we should acknowledge because they hinder mechanistic insight into the actions of oleaster oil. In particular, we could not evaluate the modifications of plasma and lipoprotein fatty acid profiles associated with oleaster oil consumption. Hence, we rely in food composition tables to estimate intakes and compliance. Also, the oil that we used had an acidity value higher that the limit set for extra virgin olive oil. However, oleaster oil as such does not fall into the same commercial classification of olive oil. Further, the batch that was produced was not meant for sale but only to be employed in this research.

In conclusion, we show that oil obtained from feral olive trees, i.e., oleasters, improves the plasma lipid profile of healthy volunteers. Even though oleaster oil is commercially available, exploitation of these results will likely be quantitatively very limited. However, our data (1) provide some scientific rationale to the past, historical medicinal use of oleaster oil and (2) might translate into actions to protect the ecosystem of this nontimber forest product.

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