9.1.1. ***Pistacia atlantica*** Desf., Fl. Atlant. 2: 364 (1799); Boulos, Fl. Egypt 2: 76 (2000).

Proximate Composition and Proteins

The proximate analyses of *Pistacia atlantica* and *Pistacia khinjuk* seeds from 3 different climates in Iran have been carried out and compared to those of cereals (Tables 2-4). The crude protein of the two pistachios seeds is very similar to that of corn, and little lower than that of other grains. The protein has a relatively high amount of threonine, serine, valine and lysine (Tables 5 and 6) (Saffarzadeh *et al*., 1999). The chemical composition of the fruits of the north Algerian ecotype *Pistacia atlantica* subsp. *atlantica* was determined and compared to other fruits of different species in the genus growing in south Algeria and other Mediterranean regions. These fruits were analyzed for their dry matter, protein, crude oil, ash, fatty acids, and phytosterol content (Tables 7 and 8). The fruits of the north ecotype were found to be rich in protein, oil, fiber, and unsaturated fatty acids, suggesting that they may be valuable for food uses (Benhassaini *et al*., 2007). The proximate analysis of *Pistacia atlantica* subsp. *mutica* and subsp. *kurdica*, compared with *Pistacia vera* are shown in Table 9.

Lipids

Pistacia atlantica oil has been reported to contain oleic acid 72.6, linoleic acid 12.4, palmitic acid 11.2, stearic acid 2.2, and palmitoleic acid 1.6%, and can be incorporated into cosmetics such as vanishing and antiwrinkle creams, lipsticks, shampoos, and hair sprays (Laserson *et al*., 1970). The main fatty acids of the fruits were oleic (54.15%), linoleic (28.84%), and palmitic (12.21%) acids (Table 10). The sterols isolated were campesterol, stigmasterol, β-sitosterol, and Δ^5-avenasterol with β-sitosterol as the major constituent (85% ± 0.85). The biochemical data indicated an elevated main unsaturated fatty acids rate (~56%) in *Pistacia* oil which may be important against certain pathologies for its nutritional and preventive virtues (Benhassaini *et al*., 2007)

The fruit of *Pistacia atlantica* gives an excellent edible oil (Daneshrad and Aynehchi, 1980; Yousfi *et al*., 2002, 2005). The fruits of *Pistacia atlantica* subsp. *mutica* and *Pistacia atlantica* subsp. *kurdica* are consumed by the natives in Iran because of the high content of oil in kernels and outer skin layers. The kernels of both species are rich in oil (over 50%), and the oil content in the outer skin layer of *Pistacia atlantica* subsp. *kurdica* is 63% and in the other species 30%. The composition of the outer skin and kernel oil of both species are shown in Table 11 (Daneshrad and Aynehchi, 1980). The fruit of the plant growing in Algeria is rich in oil (45%). The fatty acids of which are characterized as $C_{16:0}$ (24%), $C_{16:1}$ (1.2%), $C_{18:0}$ (1.8%), $C_{18:1}$ (46%) and $C_{18:2}$ (27.4%) (Yousfi *et al*., 2002). The seed oil amounts to 56.62% (Ghalem and Benhassaini, 2007). The sterol fraction of the oil contains β-sitosterol (87%), cholesterol (1.5%), campesterol (4.3%), Δ^5-avenasterol (4%) and Δ^7-avenasterol (4%) (Yousfi *et al*., 2002). The fatty acids of the seed oils of *Pistacia atlantica* and *Pistacia vera* are shown in Table 12. The sterols of the seed oil were identified as β-sitosterol (91%), campesterol (5%) and stigmasterol (4%) (Ghalem and Benhassaini, 2007). Agar *et al.* (1995) studied the fat content and fatty acid composition in kernels and epicarps

Table 2. Comparison of the chemical composition of *Pistacia atlantica* and *Pistacia khinjuk* with some cereal grains*

Components (I)	*Feedstuffs (2)*								
	P.at.	*P.kh.*	*Corn*	*Sorghum*	*Barley*	*Wheat*	*Triticale*	*Rye*	*Oat*
Dry matter %	95.13	95.90	89.00	87.00	89.00	89.00	90.00	88.00	89.00
Crude protein. %	8.10	9.15	8.50	8.80	11.00	11.50	14.00	12.10	11.40
Crude fat %	26.80	39.10	3.80	2.90	1.80	2.50	1.50	1.50	4.20
Crude fibre %	32.43	22.85	2.20	2.30	5.5	3.00	4.00	2.20	10.80
Ca,%	0.11	0.14	0.02	0.04	0.30	0.05	0.05	0.06	0.06
P,%	0.16	0.19	0.28	0.30	0.36	0.31	0.30	0.32	0.27
Mg,%	0.05	0.06	0.12	0.15	0.14	0.10	-	0.12	0.16
K,%	0.73	0.89	0.30	0.35	0.48	0.42	0.36	0.46	0.45
Na,%	0.05	0.02	0.02	0. 01	0.04	0.06	-	0.02	0.08
Mn, mg/kg	5	6.15	7.00	15.00	18.00	24.00	43.00	58.00	43.00
Cu, mg/kg	8.33	7.85	3.00	10.00	10.00	7.00	8.00	7.00	8.00
Zu, mg/kg	12.73	11.90	18.00	15.00	30.00	28.00	32.00	31.00	38.00
Fe, mg/kg	51.67	36.00	45.00	45.00	78.00	40.00	44.00	60.00	85.00
Se, mg/kg	0.06	0.05	0.03	0.20	0.10	0.06	-	0.38	0.30
Threonine,%	0.27	0.36	0.29	0.29	0.37	0.32	0.36	0.36	0.43
Serine,%	0.44	0.53	0.37	0.40	0.46	0.55	0.52	0.52	0.40
Glycine,%	0.37	0.43	0.33	0.31	0.44	0.49	0.48	0.49	0.50
Cystine,%	0.10	0.13	0.18	0.17	0.24	0.22	0.26	0.19	0.22
Valine,%	0.41	0.50	0.40	0.44	0.52	0.44	0.51	0.56	0.68
Methionine,%	0.05	0.08	0.18	0.16	0.18	0.15	0.26	0.17	0.18
Isoleucine,%	0.32	0.37	0.29	0.35	0.37	0.42	0.39	0.47	0.52
Leucine,%	0.67	0.73	1.00	1.14	0.76	0.59	0.76	0.70	0.89
Tyrosine,%	0.26	0.31	0.30	0.34	0.35	0.39	0.32	0.26	0.53
Phenylalanine,%	0.45	0.49	0.38	0.47	0.56	0.45	0.49	0.56	0.59
Lysine,%	0.52	0.52	0.26	0.21	0.40	0.31	0.39	0.42	0.50
Histidine,%	0.23	0.24	0.23	0.22	0.27	0.20	0.26	0.26	0.24
Arginine,%	0.63	0.78	0.38	0.35	0.52	0.40	0.57	0.53	0.79
Linoleic acid,%	4.96	5.37	2.2	1.13	0.83	0.59	-	-	1.47

* Saffarzadeh *et al.* (1999)

Table 3. Gross chemical composition of *Pistacia atlantica* and *Pistacia khinjuk* seeds*

Sample name (I)	Dry matter	Crude protein	Crude fat	Crude fibre	Crude ash	N.F.E	Starch
	(g/100g sample)						
1. *Pistacia atlantica*-C1	95.30	7.40	24.30	33.80	2.10	27.70	5.40
2. *Pistacia atlantica*-C2	95.00	8.70	25.90	32.70	2.10	25.60	4.90
3. *Pistacia atlantica*-C3	95.10	8.20	30.20	30.80	2.00	23.90	5.40
Mean	95.13	8.10	26.80	32.43	2.07	25.73	5.23
± SD	0.15	0.66	3.05	1.52	0.06	1.90	0.29
4. *Pistacia khinjuk*-C1	95.70	9.60	38.00	22.70	2.50	22.90	4.40
5. *Pistacia khinjuk*-C2	96.10	8.70	40.20	23.00	2.50	21.70	4.40
Mean	95.90	9.15	39.10	22.85	2.50	22.30	4.40
± SD	0.28	0.64	1.56	0.21	0.00	0.85	0.00

Cl: Tropical climate C2: Mediterranean climate, C3: cold climate
* Saffarzadeh *et al.* (1999)

Table 4. Micro-and macroelement content of *Pistacia atlantica* and *Pistacia khinjuk* seeds*

Sample name (I)	*Microelements (mg/kg)*									
	Ca	P	Mg	K	Na	Mn	Cu	Zn	Fe	Se
1. *Pistacia atlantica*-C1	1.60	1.92	0.50	8.00	76.00	9.20	14.80	19.60	72	0.06
2. *Pistacia atlantica*-C2	1.00	1.67	0.49	6.70	980.00	3.10	4.20	9.00	48	0.06
3. *Pistacia atlantica*-C3	0.80	1.40	0.45	7.30	500.00	2.70	6.00	9.60	35	0.06
Mean	1.13	1.56	0.48	7.33	518.67	5.00	8.33	12.73	51.67	0.06
± SD	0.42	0.14	0.03	0.65	452.29	3.64	5.67	5.67	18.77	0.01
4. *Pistacia khinjuk*-C1	1.45	1.90	0.65	9.30	42.00	4.90	8.70	12.80	50	0.06
5. *Pistacia khinjuk*-C2	1.40	1.90	0.63	8.40	280.00	7.40	7.00	11.00	22	0.05
Mean	1.43	1.90	0.64	8.85	161.00	6.15	7.85	11.90	36	0.05
± SD	0.04	0.00	0.01	0.64	168.29	1.77	7.00	1.27	19.80	0.01

Cl: Tropical climate, C2: Mditerranean climate, C3: cold climate
* Saffarzadeh *et al.* (1999)

Table 5. Essential amino acid content of *Pistacia atlantica* and *Pistacia khinjuk* seeds*

Species	Threonine	Cystine	Valine	Methonine	Isoleucine	Leucine	Tyrosine	Phenylalanine	Lysine
1. *Pistacia atlantica*-C1	0.24	0.08	0.35	0.07	0.28	0.04	0.24	0.43	0.47
2. *Pistacia atlantica*-C2	0.28	0.10	0.46	0.04	0.32	0.69	0.27	0.44	0.55
3. *Pistacia atlantica*-C3	0.29	0.11	0.41	0.03	0.37	0.67	0.27	0.47	0.53
Mean	0.27	0.10	0.41	0.05	0.32	0.67	0.26	0.45	0.52
± SD	0.03	0.02	0.06	0.02	0.05	0.03	0.02	0.02	0.04
4. *Pistacia khinjuk*-C1	0.36	0.14	0.53	0.09	0.38	0.76	0.30	0.02	0.52
5. *Pistacia khinjuk*-C2	0.35	0.11	0.47	0.07	0.35	0.70	0.32	0.55	0.52
Mean	0.36	0.13	0.50	0.08	0.37	0.73	0.31	0.49	0.52
± SD	0.01	0.02	0.04	0.01	0.02	0.04	0.01	0.08	0.00

C1: tropical climate, C2: Mediterranean climate, C3: cold climate. * Saffarzadeh et al. (1999)

Table 6. Non-essential amino acid content of *Patacia atlantica* and *Pistacia khinjuk* seeds*

Species	Aspartic acid	Serine	Glutamic acid	Proline	Glycine	Alanine	Histidine	Arginine	Ammonia
1. Pistacia atlantica-C1	0.61	0.40	1.45	0.53	0.37	0.35	0.23	0.51	0.08
2. *Pistacia atlantica*-C2	0.81	0.48	1.72	0.62	0.39	0.41	0.26	0.73	0.07
3. *Pistacia atlantica*-C3	0.78	0.44	1.54	0.50	0.34	0.42	0.21	0.64	0.10
Mean	0.73	0.44	1.57	0.55	0.37	0.39	0.23	0.63	0.08
± SD	0.11	0.04	0.14	0.06	0.03	0.04	0.03	0.11	0.02
4. *Pistacia khinjuk*-C1	0.88	0.55	1.80	0.53	0.46	0.84	0.26	0.76	0.16
5. *Pistacia khinjuk*-C2	0.22	0.50	1.42	0.50	0.40	0.47	0.21	0.80	0.10
Mean	0.90	0.53	1.61	0.52	0.43	0.48	0.24	0.78	0.13
± SD	0.03	0.04	0.27	0.02	0.04	0.01	0.04	0.03	0.04

C1: tropical climate, C2: Mediterranean climate, C3: cold climate. * Saffarzadeh *et al.* (1999

Table 7. Comparison between chemical composition of Algerian (North Ecotype) and Iranian *Pistacia atlantica* species*

%	*Pistacia atlantica*	
	Algerian north ecotype	Iranian ecotype
Moisture	21.26±1.24	14.87±1.32
DM (dry matter)	78.74±0.48	95.13±0.15
Crude oil	39.80±1.37	26.80±3.05
Crude fibres	12.60±0.71	32.43±1.52
Crude proteins (N×6.25)	10.39±0.66	8.20±0.40
Ash	5.54±0.11	2.07±0.06
Starch	5.43±0.35	5.23±0.29

* Benhassaini *et al.* (2007)

Table 8. Comparison of sterol composition of Turkish *Pistacia vera* (Uzun Variety) and Algerian (North Ecotype) *Pistacia atlantica* oils *

Sterol composition	*Pistacia vera* Turkish (Uzun variety)	*Pistacia atlantica* Algerian (north ecctype)
	Concentration, %	
β-Sitosterol	82.30±0.04	85±0.85
Campesterol	0.55±0.01	4±1.10
Stigmasterol	6.40±0.01	11±0.35
Δ^5-Avenasterol	1.90±0.16	3.80±0.10

* Benhassaini *et al*. (2007)

of the individual seeds of *Pistacia atlantica*, *Pistacia khinjuk* and *Pistacia terebinthus* grown in different parts of Turkey. All three pistachio species were rich from the point of fat content and differed significantly from each other. Palmitic acid content of the hulls (23.49-27.98%) were more than two-fold that of the kernel (9.55-11.95%). Palmitoleic acid content of the kernels was relatively low (< 1%) in comparison to the hull (1.32-5.05%). Stearic acid was found as the second main fatty acid (1.13-2.18%) in the kernel whereas it was between 1.46-4.24% in the hull. The main unsaturated fatty acid in kernels and hulls of the three *Pistacia* species was oleic acid (48.49-50.83%). Linoleic acid was the dominant polyunsaturated fatty acid in kernels (33.48-37.50%), whereas this was much lower in the hull (12.90-22.03%) (Agar *et al*., 1995). The fatty acid composition of dehulled *Pistacia atlantica* and *Pistacia khinjuk* seeds, growing in 3 different climates in Iran is shown in Table 13 (Saffarzadeh *et al*., 1999). The fatty acids of the fruits of *Pistacia atlantica* var. *mutica*, growing in Iran are shown in Table 14. The composition of mastic tree (*Pistacia atlantica*) fruit oil of Algeria with respect to fatty acids (FA) and sterols was analysed and compared with the oils of the *Pistacia* species. The major sterol of *Pistacia atlantica* fruit oil is β-sitosterol, which is also present in *Pistacia vera* from Turkey. The FA composition of *Pistacia atlantica* is very similar to that of *Pistacia lentiscus* oil from France and *Pistacia terebinthus* from Turkey. *Pistacia atlantica* oil is rich in unsaturated fatty acid (oleic + linoleic, 73.4%) (Yousfi *et al*., 2002). The analysis of both total and free fatty acids in *Pistacia atlantica* fruit oil showed a predominance of oleic, linoleic and palmitic acids. The nature of the total and free fatty acids fractions are the same (Yousfi *et al*., 2003).

Pistacia atlantica subsp. *mutica* (PAM) and *kurdica* (PAK) kernel oils showed significantly lower unsaturated to saturated fatty acid ratios (6.39, 6.33, respectively) and calculated oxidizability (Cox) values (3.99, 4.13, respectively) than those of the *Pistacia vera*

Table 9. Characteristics of some *Pistacia* nuts*

Species	Shape	Wt. of 100 nuts (g)	Kernel (%)	Moisture in kernel (%)	Ash in kernel (%)	Oil content		Unsaponifiable content of oils	
						Kernel (%)	Outer skin (%)	Kernel (%)	Outer skin (%)
Pistacia atlantica subsp. *mutica*	Hazlenut	5.51	25.40	2.70	2.70	57	30.10	0.49	1.58
Pistacia atlantica subsp. *kurdica*	Hazlenut	6.56	18.73	2.60	2.70	54	63	0.49	1.54
Pistacia vera L. (I)	Almond	78-136	48-55	3.3-4	…	55-57	…	0.54	…
Pistacia vera L. (I)	Hazlenut	85-125	44-50	3.1-4.1	…	56-58	…	…	…

* Daneshrad and Aynehchi (1980)

Table 10. Comparison of fatty acid composition of Iranian, Turkey *Pistacia terebenthus*, and Algerian (North ecotype) *Pistacia atlantica* fruit oils*

Fatty acids (FA)	*Pistacia atlantica* (Iranian ecotype)	*Pistacia terebenthus* (Turkey)	*Pistacia atlantica* (Algerian north ecotype)
	Concentration, %		
12:0		0.1±0.02	0.07±0.02
14:0	0.07±0.00	0.1±0.03	0.09±0.01
16:0	17.29±1.41	21.30±0.21	12.21±0.48
16:1 n-9	6.09±0.60	3.4±0.10	1.77±0.06
18:0	2.35±0.18	2±0.32	2.39±0.12
18:1 n-9	54.66±0.89	52.3±0.17	54.15±0.30
18:2 n-6	18.51±2.27	19.7±0.40	28.84±0.23
18:3 n-6	0.59±0.02	0.6±0.01	0.42±0.46
20:0	0.02±0.11	0.2±0.01	0.05±0.01
Total saturated FA	19.71±0.39	23.5±0.14	14.76±0.15
Total monounsaturated FA	60.75±0.79	57.7±0.13	55.92±0.18
Total polyunsaturated FA	19.12±0.80	20.5±0.14	29.31±0.23

* Benhassaini *et al*. (2007)

Table 11. Fatty acid composition (%) of kernels and outer skin oil of *Pistacia atlantica* subsp. *mutica* and *kurdica**

Acid	*Pistacia atlantica* subsp. *mutica*		*Pistacia atlantica* subsp. *kurdica*	
	kernels	Outer skin	Kernels	Outer skin
C14:0	0.06	0.03	0.07	0.01
C16:0	12.20	2.4	12.48	24.50
C18:0	2.20	2.10	2.50	2.20
C20:0	Trace	Trace	…	Trace
C16:1	1.90	12.80	1.53	6.80
C18:1	50.40	55.80	57	54.79
C20:1	…	0.10	…	…
C18:2	32.80	4.50	25.80	11.30
C18:3	0.40	0.70	0.50	0.40

* Daneshrad and Aynehchi (1980)

Table 12. The fatty acids composition of oil seeds of *Pistacia atlantica* and *Pistacia vera**

Fatty Acids	*Pistacia atlantica* %	*Pistacia vera* %
Lauric acid	0.07	0.10
Myristic acid	0.09	0.19
Plamitic acid	12.21	11.55
Plamitoleic acid	1.77	0.58
Stearic acid	2.39	15.21
Oleic acid	54.15	65.64
Linoleic acid	28.84	4.81
Linolenic acid	0.42	1.35
Arachidonic acid	0.05	0.58
Saturated acids	14.81	27.62
Monounsaturatcd acids	55.92	66.22
Polyunsaturated acids	29.27	6.16
Total	100	100

* Ghalem and Benhassaini (2007)

L. cv. Ohadi (PVO) kernel oil (8.91, 4.41) samples. The highest peroxide value was observed for the PAK oil (4.07 mequiv kg-1) (PAM, 1.94; PVO, 0.37) samples. Iodine values for the PAM, PAK, and PVO oils were 104.26, 104.77, and 110.66, respectively. The unsaponifiable contents, which were composed mainly of sterols, ranged from 5.63 to 6.14%. Statistically the total tocopherols contents of the PAM (818.58 mg α-tocopherol kg-1) and PVO (815.90 mg α-tocopherol kg-1) oils were significantly higher than that of the PAK oil (499.91 mg α-tocopherol kg-1). Total phenolic contents differed significantly, the greatest concentration was for the PAM oil (81.12 mg gallic acid kg-1), followed by the PVO (62.84 mg gallic acid kg-1) and PAK (56.51 mg gallic acid kg-1) oil samples. The wax contents of the oil samples were statistically in the same range, namely 5.67-6.48%. Oxidative stability data indicated that the PAM oil is the most resistant to the formation of lipid oxidation products, followed by the PAK and PVO oil samples. The chemical characteristics and the fatty acid

Table 13. Fatty acid composition of *Pistacia atlantica* and *Pistacia khinjuk* seeds*

Species	14:0	16:0	16:1	18:0	18:1	18:2	20:0	20:1	18:3
1. *Pistacia atlantica*-C1	0.07	17.76	5.40	2.56	54.41	18.76	0.17	0.26	0.16
2. *Pistacia atlantica*-C2	0.07	15.71	6.29	2.22	53.93	20.64	0.15	0.39	0.60
3. *Pistacia atlantica*-C3	0.07	18.40		2.27	55.65	16.13	0.13	0.19	0.57
			6.59						
Mean	0.07	17.29	6.09	2.35	54.66	18.51	0.15	0.28	0.59
± SD	0.00	1.41	0.60	0.18	0.89	2.27	0.02	0.10	0.02
4. *Pistacia khinjuk*-C1	0.10	21.83	4.42	2.08	57.34	13.19	0.11	0.21	0.72
5. *Pistacia khinjuk*-C2	0.07	20.80	4.06	2.27	57.47	14.29	0.15	0.20	0.69
Mean	0.09	21.32	0.24	2.18	57.41	13.74	0.13	0.21	0.71
± SD	0.02	0.73	0.25	0.13	0.09	0.78	0.03	0.01	0.02

Myristic acid 14:0; palmitic acid 16:0; palmitoleic acid 16:1; stearic acid 18:0; oleic acid 18:1; linoleic acid 18:2; eicosanoic acid 20:1; linolenic acid 18:3; behenic acid 20:0.

* Saffarzadeh *et al.* (1999)

Table 14. Fatty acid composition (%) of oils of some *Pistacia* species*

Fatty acids	*Pistacia khinjuk*	*Pistacia atlantica* var. *mutica*	*Pistacia vera* cv ohadi
14:0	0.04±0.06	0.33±0.57	0.06±0.09
16:0	17.82±0.11	10.7±0.51	8.5±0.50
16:1	5.73±0.07	1.81±0.18	1.23±0.30
17:0	0.4±0.02	-	-
17:1	0.43±0.09	-	-
18:0	2.61±0.08	2.44±0.33	1.48±0.48
18:1	52.12±0.16	51.73±0.43	51.46±0.70
18:2	17.44±0.62	31.34±1.02	35.85±0.76
18:3	1.5±0.07	1.16±0.12	0.95±0.70
20:1	0.76±0.06	-	-
22:1	0.88±0.06	-	-
Sataurated	20.83±0.17	13.47±1.16	10.04±1.13
Unsaturated	78.44±0.57	86.04±0.65	89.49±0.95
Total	99.73±0.34	99.51±0.28	99.53±0.39

* Tavakoli and Pazhouhanmehr (2010)

composition of the kernel oils of the two subspecies are shown in Tables 15 and 16 (Farhoosh *et al*., 2008).

The antirancidity (antioxidant) effect of Bene (*Pistacia atlantica* subsp. *mutica*) hull oil has been reported. The antioxidant activity of the oil was exactly the same as that of *tert*-butylhydroquinone (TBHQ) at low concentrations (100 ppm) (Farhoosh *et al*., 2009). The oil had a better protective effect on the indigenous tocopherols of sunflower during frying (Farhoosh and Tavassoli-Kafrani, 2010). The unsaponifiable (USM) constituents of the Bene hull oil (BHO) were separated into hydrocarbons (3.7%), carotenes (3.6%), tocopherols and tocotrienols (24.7%), linear and triterpenic alcohols (0.9%), methylsterols (5.7%), sterols (3.2%), triterpenic dialcohols (4.7%), and triterpenic dialcohol methylesters (4.5%). The results obtained from the measurements of total polar compounds, conjugated diene value,

Table 15. Chemical characteristics of the kernel oils of two subspecies of *Pistacia atlantica* and *Pistacia vera* L. cv. Ohadi *

Fatty acid	The kernel oils from		
	PAM	PAK	PVO
PV (mequiv O_2/kg oil)	1.94±0.04	4.07±0.20	0.37±0.07
IV(g of I_2/100 g oil	104.26±0.48	104.77±46	110.66±1.26
SN(mg KOH/g oil)	108.19±1.83	108.72±1.70	118.80±2.06
USM content (% of oil)	5.63±0.90	5.92±0.28	6.14±0.72
TS content (% of oil)	5.37±0.49	5.89±0.70	5.73±0.02
TT content(mg &-tocopherol/kg oil)	818.58±14.90	499.91±18.46	815.90±8.29
TP content (mg gallic acid/kg oil	81.12±1.73	56.51±1.49	62.84±1.02
Wax content (% of oil)	6.48±0.32	5.67±0.48	6.39±0.38

PAM: *Pistacia atlantica* subsp. *mutica*, PAK *Pistacia atlantica* subsp. *kurdica,* PVO*:* *Pistacia vera* L. cv. Ohadi, PV: peroxide value; IV: iodine value ; SN: saponification number ; USM: unsaponifiable matter ; TS : total sterols ; TT : total tocopherols TP : total phenolics .
* Farhoosh *et al.* (2008)

Table 16. Fatty acid Composition (%) of the kernel oils from two subspecies of *Pistacia atlantica* and from *Pistacia vera* L. cv. Ohadi**

Fatty acid	The kernel oils from		
	PAM	PAK	PVO
C14:0	0.±0.57	0.08±0.09	0.06±0.12
C16:0	10.70±0.51	10.68±0.15	8.50±0.50
C16:1	1.81±0.18	1.89±0.23	1.23±0.30
C18:0	2.44±0.33	2.76±0.47	1.48±0.48
C18:1	51.73±0.13	50.42±0.59	51.46±0.07
C18:2	31.34±1.02	32.39±0.31	35.85±0.76
C18:3	1.16±0.12	1.35±0.22	0.95±0.70
Others	0.49±0.37	0.43±0.42	0.47±0.70
SFA	13.47±1.16	13.52±0.46	10.04±1.13
MUFA	53.54±0.18	52.31±0.36	52.69±0.32
PUFA	32. 50±1.11	33.74±0.41	36.80±1.41
USFA/SFA	6.39±0.55	6.33±0.23	8.91±1.01
CoxValue	3.99±0.12	4.13±0.06	4.41±0.22

PAM: *Pistacia atlantica* subsp. *mutica*, PAK *Pistacia atlantica* subsp. *kurdica,* PVO: *Pistacia vera* L. cv. Ohadi, SFA: saturated fatty acids, MUFA: monounsaturated fatty acids, PUFA: polyunsaturated fatty acid, USFA: unsaturated fatty acids, Cox: calculated oxidizability

* Farhoosh *et al.* (2008)

carbonyl value, and acid value during 32 hours of frying showed that the frying stability of sunflower oil (SFO) improves more in the presence of the USM of BHO than in the presence of TBHQ. Moreover, compared to TBHQ, the USM had a better protective effect on the indigenous tocopherols of SFO during frying (Farhoosh *et al*., 2010). Also, the USM of bene hull oil were separated into hydrocarbons (7.3%), carotenes (7.1%), tocols (48.4%), linear and triterpenic alcohols (1.7%), Me sterols (11.2%), sterols (6.2%), and triterpenic dialcohols (18.0%) (Farhoosh *et al*., 2011).

Essential Oils and Oleoresin

The essential oils, obtained from the oleoresin of the plant, growing in different countries have been investigated. In the study of Delazar *et al.* (2002), the oleoresin is obtained by scratching the body of the tree at end of spring season from Kordestan province (Iran). The amount of essential oil obtained from the resin was 22% v/wt. α-Pinene was the major component of the oil (94.58%). Barrero *et al*. (2005) reported the chemical composition of the three essential oils obtained from the resin, leaves and fruits of *Pistacia atlantica*, growing in Morocco. Monoterpene hydrocarbons were found to constitute the main chemical group in the resin oil, with α-pinene (42.9%) and β-pinene (13.2%) as the major components. Oil of the fruits contained high amounts of oxygenated monoterpenes, with bornyl acetate(21.5%) as the major component, while oxygenated monoterpenes and sesquiterpenes were found to dominate in the oil of leaves among which terpinen-4-ol (21.7%) and elemol (20.0%) were the most abundant components (Barrero *et al*., 2005). The components of the essential oils of the leaves (from male and female plants), unripe fruits and leaf-buds of different samples of *Pistacia atlantica* collected from Greek East islands (Kalimnos and Lesvos) showed qualitative and quantitative differences among the samples and different organs of the plant (Tzakou *et al*., 2007). The oils were rich in monoterpenes. The main components in the leaf oil from the female plants were myrcene (17.8%, 24.8%) and terpinen-4-ol (11.6%, 6.0%) in the Kalimnos and Lesvos samples, respectively, while in the leaf oil from the male plants terpinen-4-ol (17.3% Kalimnos) and *p*-mentha-1(7),8-diene (41.1%, Lesvos) were the dominant constituents. The major components in unripe fruits were terpinen-4-ol (25.7%, 8.9%), myrcene (20.2%, 34.5%) and sabinene (14.9%, 19.5%). In the leaf-bud oils sabinene (52.1%) and α-pinene (11.6%) were the main constituents in the Kalimnos sample, while in the Lesvos sample the major constituent was *p*-mentha-1(7),8-diene (42.4%) (Tzakou *et al*., 2007). Essential oils from leaves, fruits and galls of *Pistacia atlantica*, growing in Algeria, were dominated by monoterpene hydrocarbons; α-pinene (32.6-54.7%) and β-pinene (8.0-20%) being the major components. Sesquiterpenes accounted for 14.1-21.7% in leaf oil, 3.6% in fruit oil and 4.8% in gall oil (Mecherara-Idjeri *et al*, 2008c). Gourine *et al.* (2009) identified 31 compounds in the essential oil (0.13% v/wt) obtained by hydrodistillation of leaves of the plant growing in Algeria. The main components were β-pinene (19.08%), α-terpineol (12.82%), bicyclogermacrene (8.15%) and spathulenol (9.45%). Analysis of the essential oil of unripe galls collected from both male and female trees (0.53% and 0.46% v/w, respectively) revealed the occurrence of a Δ^3-carene rich chemotype (75.34%). The second is the well known chemotype α-pinene/β-pinene, which is rich in α-pinene (59.01) and β-pinene (13.26%) (Gourine *et al*., 2011). Boztok and Cokuysal (2007) reported that the essential components of the gum mastics fom *Pistacia atlantica* and other species from the Aegean coast belt of Turkey and the mastics from Chios Island of Greece, the unique producer of mastic, have similar characteristics.

The essential oils obtained from *Pistacia atlantica* leaves collected from different regions of Algeria were rich in monoterpenes and oxygenated sesquiterpenes. The major components were α-pinene (0.0-67%), Δ^3-carene (0.0-56%), spathulenol (0.5-22%), camphene (0.0-21%), terpinen-4-ol (0.0-16%) and β-pinene (0.0-13%). Among the various components identified, twenty were used for statistical analyses. The result of principal component analysis (PCA) showed the occurrence of 3 chemotypes: a Δ^3-carene chemotype (16.4-56.2%), a terpinen-4-ol chemotype (10.8-16.0%) and an α-pinene/camphene chemotype (10.9-66.6%/3.8-20.9%). It was found that the essential oil from female plants (Δ^3-carene chemotype) could be easily differentiated from the two other chemotypes corresponding to male trees (Gourine *et al*, 2010a). The study of the seasonal variation of chemical composition of the leaves essential oil revealed that the main components of male essential oil were α-pinene/α-thujene, spathulenol and bicyclogermacrene. The major component of female essential oil was Δ^3-carene. The seasonal variation showed that most of the main components of the oils reached theirs highest values in September (Gourine *et al*., 2010b). The essential oils of 34 samples (collected from four different locations in Algeria) obtained at a yield of 0.02 - 0.12% (v/w). Forty-seven compounds were identified. The main compounds were not the same in the all analyzed samples. The percentage ranges of the major components identified from the different locations were α-pinene + α-thujene (5.54-66.61%), camphene (0.75-20.85%), β-pinene (1.09-13.12%), *p*-cymene (0.39-10.19%), terpinen-4-ol (0.42-15.97%) and spathulenol (0.46-32.64%) (Gourine *et al*., 2010c).

The *ex situ* volatile analysis of leaves from *Pistacia atlantica*, *Pistacia chinensis*, *Pistacia lentiscus*, *Pistacia palaestina*, *Pistacia terebinthus*, *Pistacia vera* and *Pistacia weimannifolia* (grown in California) demonstrated emission differences between species as well as between female and male leaves. Leaves from the female *Pistacia vera* cultivars Bronte, Damghan, II, III, Kerman and Ohadi as well as fruits of *Pistacia atlantica*, *Pistacia chinensis*, *Pistacia lentiscus*, *Pistacia palaestina*, *Pistacia terebinthus and Pistacia vera* (cultivars II, III, Kaleh, Kerman, Momtaz and Ohadi) showed differences in the composition and relative quantity of major volatiles. The compounds in highest relative quantities from the various analyses were sabinene, Δ^3-carene, β-myrcene, α-phellandrene, limonene, (*Z*)-ocimene, (*E*)-β-ocimene and α-terpinolene. The study provides an overview of the major and minor volatile emissions and also offers evidence of chemotypes based on monoterpenes. The results highlight the dissimilarity of major components detected between *ex situ* volatile collection and essential oil analysis (Roitman *et al*., 2011). The top two major components for *Pistacia atlantica* (growing in California) female leaves are (*E*)-β-ocimene followed by sabinene, and for male flowers are (*E*)-β-ocimene followed by (*E*)-4,8-dimethyl-1,3,5-nonatriene and α-pinene essentially tied for distant second. These major components are different from the report on *Pistacia atlantica* male and female leaves collected from Algiers (Gourine *et al*., 2010b), which showed that the top two components from female leaves were Δ^3-carene with α-terpinyl acetate in distant second and for male leaves were α-pinene/α-thujene mixture as top monoterpene followed by spathulenol. and bicyclogermacrene It is not known whether the chemical composition disparities are due to geographical differences or method of volatile collection (essential oil *versus ex situ*); however the results from a study of female and male leaves from Greece (Tzakou *et al*., 2007) show different major volatiles from *Pistacia atlantica* than those noted above. This is suggestive of geography playing an important role in *ex situ* volatile emissions, though not conclusive (Roitman *et al*., 2011). The volatile emission of fruits of *Pistacia atlantica* and some other species is shown in Table 17 and 18 (Roitman *et al*., 2011).

Table 17. *Ex situ* volatile emission of fruits from some *Pistacia* species*

Identity	*Pistacia atlantica*	*Pistacia chinensis*	*Pistacia lentiscus*	*Pistacia palaestina*	*Pistacia terebinthus*
1. α-Pinene	4.5	1.4	5.5		8.3
2. α-Thujene	2.2				
3. β-Pinene	2.0				8.1
4. Sabinene	46.1		58.5	6.4	5.3
5. Δ^3-Carene		40.2			
6. β-Myrcene	30.4	20.8	26.9	9.6	2.7
7. α-Phellandrene		6.6		11.4	17.5
8. Limonene	5.7	5.6	3.8	69.5	17.8
9. β-Phellandrene	3.7	4.7		3.1	13.8
10. (*E*)-β-Ocimene		3.7	2.7		2.2
11. α-Terpinolene		9.5			3.7
12. (*E*)-4,8-Dimethyl-1,3,7-nonatriene		1.3			
13. α-Cubebene					3.1
14. α-Ylangene					0.9
15. β-Cubebene					2.1
16. Bornyl acetate	3.3		2.5		1.8
17. β-Caryophyllene		6.2			1.3
18. Unidentified sesquiterpene					0.9
19. α-Terpinyl acetate/ledene					0.9
20. Germacrene D	2.1				6.4
21. Bicyclogermacrene					3.1

* Roitman *et al*. (2011)

Table 18. *Ex situ* volatile emission of leaves from female (F) *Pistacia* cultivars and male (M) pollinator *Pistacia* species*

	Pistacia atlantica		*Pistacia chinensis*		*Pistacia lentiscus*		*Pistacia palaestina*		*Pistacia terebinthus*		*Pistacia vera* cv. kerman		*Pistacia weimannifolia*	
Compounds	F	M	F	M	F	M	F	M	F	M	F	M	F	M
1. α-Pinene	5.7	9.9	1.0	0.5	7.2	6.6	0.5	14.6	9.8	5.9	0.6	6.2	3.3	3.1
2. α-Thujene	1.2				1.0									
3. Camphene	1.0	1.9				0.3			1.1	0.6		1.2	0.3	0.3
4. β-Pinene	2.5	4.0			2.7	3.4		2.5	5.3	1.9		0.3	0.9	0.8
5. Sabinene	27.4	2.5			16.5	2.1	0.8		2.2	1.0			0.6	0.6
6. Unidentified Monoterpene								0.2				1.3		
7. Δ^3-Carene			5.0	17.3			0.4	1.7			1.3	9.3		
8. β-Myrcene	5.9	4.6	2.5	60.4	7.3	4.5	5.1	4.4	10.3	35.7	0.7	1.2	5.5	4.7
9. α-Phellandrene		0.3		0.9		4.4	8.4	2.3	0.3	0.2		0.6	38.9	40.8
10. α-Terpinene	1.6			0.5	4.1		0.5	1.1				4.2		
11. Limonene	1.9	2.4	0.7	2.5	10.9	58.6	65.4	43.9	2.4	1.1	53.6	6.7	21.6	17.5
12. β-Phellandrene	1.2	0.9	0.4	1.5	11.4	8.6	1.5	1.4	1.5	0.7		0.9	16.5	21.0
13. (*Z*)-Ocimene	1.0	1.6	45.5	1.1	2.5	0.8	0.5	1.1	2.7	3.8	0.7	0.1	0.3	0.2
14. γ-Terpinene	2.5	0.2			6.7	0.3		1.0				1.3	0.2	0.2
15. (*E*)-β-Ocimene	36.2	53.6	38.1	0.6	7.4	0.7	3.9	1.1	33.3	36.1	29.8	3.4	6.9	6.9
16. *p*-Cymene	0.2				1.5	0.4	0.4	0.3			0.3	0.9	2.4	2.3
17. α-Terpinolene	0.5		0.8	5.5	1.5	0.1	7.1	12.9	0.3	0.2	5.7	57.1	0.6	0.6
18. (*E*)-4,8-dimethyl 1,3,7-nonatriene	6.1	10.2	0.9	0.6	0.6	0.6	0.3	0.3	8.7	0.6	1.0	0.4	0.9	0.9
19. (*Z*)-3-Hexenyl acetate		0.4			0.1			0.4	1.0	1.9				
20. (*Z*)-3-Hexen-1-ol										0.2				
21. α-Cubebene	0.5				0.2		0.2		0.6					
22. (*Z*)-3-Hexenyl butanoate					0.1				0.2					

Table 18. *Ex situ* volatile emission of leaves from female (F) *Pistacia* cultivars and male (M) pollinator *Pistacia species*[a] * (cont.)

Identity	*Pistacia atlantica* F	*Pistacia atlantica* M	*Pistacia chinensis* F	*Pistacia chinensis* M	*Pistacia lentiscus* F	*Pistacia lentiscus* M	*Pistacia palaestina* F	*Pistacia palaestina* M	*Pistacia terebinthus* F	*Pistacia terebinthus* M	*Pistacia vera* cv. kerman F	*Pistacia vera* cv. kerman M	*Pistacia weimannifolia* F	*Pistacia weimannifolia* M
23. α-Ylangene			0.7						0.3					
24. α-Copaene/unidentified sesquiterpene			0.3		1.0				0.2					
25. β-Cubebene			2.9		0.1				0.3					
26. Linalool	0.6	0.4	0.6						0.4	0.6		0.3	0.3	0.2
27. Bornyl acetate	0.3	0.3	0.6									0.9		
28. α-Guaiene			0.3											
29. β-Caryophyllene				7.0	1.2	3.4	1.2	9.5	7.6	0.8			0.2	
30. 2-Undecanone						0.1								
31. Terpineol-4					0.5									
32. Aromadendrene					0.6							0.1		
33. Methyl benzoate		0.4							0.6	2.1	5.8	3.4		
34. α-Humulene/t-β-Farnesene				0.5	0.6	0.4	0.4	1.2	0.3					
35. γ-Muurolene					1.1									
36. Germacrene D	2.5	5.1			9.8	4.4	3.2		2.9	0.4			0.2	
37. α-Amorphene					0.2									
38. Valencene/β-selinene				0.4	0.1									
39. α-Selinene/α-muurolene				0.7	0.5									
40. Bicyclogermacrene	0.5	0.2			0.1				1.1	0.2				
41. (*E*, *E*)-α-Farnesene	0.5	0.7			0.3				5.8	5.3			0.5	
42. δ-Cadinene							0.1							
43. γ-Cadinene					1.8									
44. Methyl salicylate									0.3					
45. (*Z*)-3-Hexenyl benzoate		0.4							0.4	0.6				
46. 1*H*-Indole											0.5	0.1		

* Roitman *et al*. (2011).

The essential oil obtained from the oleoresin of *Pistacia atlantica* Desf. subsp. *atlantica*, growing in arid and semi-arid regions of Algeria contained many terpenoids: α-pinene (39.4%), β-pinene (12.9%), carvacrol (11.8%), pinocarvone (5.5%) , limonene (5.1%), germacrene-D (2.4%), *trans*-pinacrveol (2.1%), camphenol (2%), borneol (2%), α-terpene (1.8%), *p*-cymene (1.7%), terpinolene (1.4%), terpinene-4-ol (1.4%), isopinacarveol (1.1%) and verbenene (1.0%). Other minor constituents were also identified (Benhassaini *et al.*, 2008).

The following 11 terpenoids have been identified in the essential oil obtained from the oleoresin of *Pistacia atlantica* var. *mutica*: α-pinene (70%), β-pinene (1.94%), 3-carene (0.2%), carveol (2.18%), epoxypinene (2.15%), limonene oxide (9%), myrtenol (5.31%), limonene (0.62%), citral (5.72%), α-phellandrene (0.2%), and β-myrcene (0.3%). The total amount of essential oil obtained was 22% v/w which is higher than any other species of the genus *Pistacia* (Delazar *et al*., 2004).

The following compounds were identified in the essential oil obtained from the oleoresin collected after tapping the trunk of the *Pistachia atlantica* tree (Persian turpentine tree, subsp. *kurdica*) grown in Iran at the end of spring and the earlier months of summer: β-caryophyllene, spiro[4,5]decane-6-methylene and β-pinene, and nine major components: α-pinene, camphene, β-pinene, bicyclo[3.1.1]hepta-3-ene-2-ol-4,6,6-trimethyl; 1,4-cyclo-hexadiene-1-methanol-4-(1-methylethyl); bicyclo[3.1.1] hepta-3-ene-2-one-4,6,6-trimethyl; β-caryophyllene and spiro[4,5]decane-6-methylene (Naseri *et al*., 2006a).

A comparative study on oleoresins from trunks of *Pistacia atlantica* plants originating in Iran and Israel revealed that both consisted of euphane, drammarane and oleanane triterpenes. The only relevant difference being the presence in the oleoresin from Iranian specimens of two pinane monoterpenes. Interestingly, *Pistacia atlantica* from Israel produces galls due to the aphid *Slavum wertheimae*, whereas the same species from Iran is gall free although this insect lives in Iran and infects other *Pistacia* species growing in the same area (Monaco *et al*., 1982). The polymers from mastic gum of *Pistacia lenticosa* and subspecies of *Pistacia atlantica* ssp. *kurdica*, *mutica* and *cabolica*) have been characterized as *cis*-1,4-poly-β-myrcenes (Sharifi *et al*., 2012).

The essential oil formed 20% of the weight of the crude gum from *Pistacia atlantica* subsp. *kurdica*. The prominent component (97.18%) is α-pinene which shows a unique characterstic for this subspecies. Other compounds detected in the oil are α-thujene (0.07%), camphene (0.41%), sabinene (0.16%), β-pinene (1.26), Δ^3-carene (0.11%) and limonene (0.06%) (Sharifi and Hazell, 2011). However, Salimi *et al*. (2011) characterized the following 18 components from the oil (7%) of this subspecies collected from Kurdistan (Iran): α-pinene (81.9%), camphene (2.7%), sabinene (0.8%), β-pinene (7.4%), δ-cymene (0.1%), limonene (1.2%), 1,8-cineole (0.1%), Δ^3-Carene (0.1%), α-terpinolene (0.4%), linalool (0.1%), α-pinene oxide (0.1%), α-campholenal (0.2%), *trans*-pinocarveol (0.9%), verbenol (2.5%), α-terpineol (0.1), myrtenol (0.1%), verbenone (0.1%) and bornyl acetate (0.7).

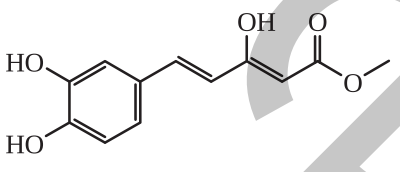
Phenolic Constituents

The following six flavonoid glycosides were isolated from the aerial parts of *Pistacia atlantica*: kaempferol 3-glucoside, quercetin 3-glucoside, quercetin 3-galactoside, quercetin 3-rhamnosylglucoside, quercetin 3-glucoside-7-galactoside and apigenin 6,8-di-*C*-glucoside (vicenin-2) (Mosharafa *et al*., 1999). Kawashty *et al.* (2000) isolated the following nine flavonoid glycosides (Table 19) from four *Pistacia* species in Egypt (*Pistacia atlantica*, *Pistacia chinensis*, *Pistacia khinjuk* and *Pistacia lentiscus*): kaemferol 3-glucoside, quercetin 3-glucoside, quercetin 3-galactoside, quercetin 3-rutinoside, quercetin 3-glucoside-7-galactoside, apigenin 6,8-di-*C*-glucoside, myricetin 3-glucoside, myricetin 3-galactoside and

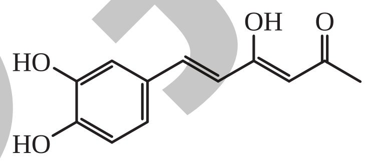
Table 19. Distribution of flavonoids in *Pistacia species*, growing in Egypt*

Species	K-3-G	Q-3-G	Q-3-Gal	Q-3-Rut	Q-3-G-7-Gal	Myr-3 -G	Myr-3-Gal	Myr-3-Rut	Vicenin-2
1. *Pistacia atlantica*	+	+ + +	+ +	+	+	--	--	--	+ +
	+	+ + +	+ +	+	+	--	--	--	+ +
	+	+ + +	+ +	+	+	--	--	--	+ +
2. *Pistacia chinensis***	+ +	+ + +		--	--	--	--	--	+
3. *Pistacia khinjuk*	--	+ +		+ +	--	+ + +	+ + +	+ + +	--
		+ +		+ +	--	+ +	+ +	+ + +	--
		+		+	--	+ +	+ +	+ + +	--
4. *Pistacia lentiscus*	+	+ + +		+	--	+	--	--	+

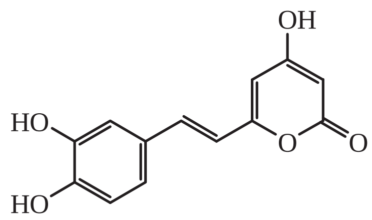
K-3-G = Kaempferol-3-glucoside; Q-3-G = quercetin-3-glucoside; Q-3-Gal = quercetin-3- galactoside; Q-3-Rut = quercetin-3-rutinoside; Q-3-G-7-Gal = quercetin-3-glucoside-7-galactoside; My-3-G = myricetin-3-glucoside; My-3-Gal = myricetin-3-; galactoside My-3-Rut = myricetin-3-rutinoside.
*Kawashty *et al*. (2000); ** collected from Zoological garden, Giza.



85



86 Hispolone



87 Hispidin

myricetin 3-rutinoside (vicenin 2). The chemotaxonomic significance has been discussed. Luteolin, luteolin 7-glycoside, kaempferol, naringine, nariningin 7-glycoside and chlorogrnic acide were isolated from the fruits (Yousfi *et al*., 2009). An antiplasmodial compound identified as flavone, 3-methoxycarpachromene was isolated from the plant (Adams *et al*., 2009).

The possibility of using *Pistacia atlantica*, growin in Libya, as a tanning material has been early reported (Vignololutati, 1914). The leaves are attacked by gall wasps and produce galls in abundance. The wasps are: *Pemphigus cornicularius* Pass. (I), *Pemphigus riccoboni* Stef. (II), and *Pemphigus utricularius* Pass. (III). Analysis of the galls showed: I, II, III a., III b.; tannins, 24.04, 29.21, 37.76, 40.32; insoluble non-tannins, 20.33, 25.74, 15.28, 12.72; insoluble, 45.01, 34.46, 35.30, 35.30; water, 10.63, 10.59, 11.66, 11.66; ash, 4.90, 4.10, 3.87, 3.87 (Bravo, 1927). A botanical description of the leaves has been early reported. The extract of the leaves was also found to contain tanning matter (Bionda, 1943).

The leaves (50 g) contain gallic acid, (46.0 mg) and gallic acid methyl ester (18.3 mg). Methyl 5-(3,4-dihydroxyphenyl)-3-hydroxypenta-2,4-dienoate (**85**), hispolone (**86**) (6-(-3,4-dihydroxyphenyl)-4-hydroxyhexa-3.5-dien-2-one) and hispidin (**87**) (6-(-2-(-3,4-dihydroxyphenyl)vinyl)-4-hydroxy-2*H*-pyran-2-one) were isolated from the mushroom *Inonotus hispidus* growing on *Pistacia atlantica* (Yousfi *et al*., 2009). The leaves have been reported to contain 22.2% of tannin (cited in Yousfi *et al*., 2009). The total phenolic content was very variable from one part to another and ranged from 23.5 for the fruit to 122.5 (mg/g dry basis) for the leaves (Table 20).

Table 20. Content of phenolic and dominant phenolic compounds expressed in percentage of each part of *Pistacia atlantica**

		Number of peaks at different wave lengths (nm)			Relative Composition (%)		
	Phenolic Content (mg/g)	280	320	240 – 260 & 340 - 380	HB	HC	F
Fruits	23.5	3	1	7	5	<1	95
Leaves	117.3	7	1	3	92	<1	8
Galls	113.7	9	-	1	98	-	2
Inonotus hispidus	54.8	1	1	3	-	1	99

HB: Benzoic acid derivatives, HC: Hydroxycinnamic acid derivatives, F: Flavonoids.
* Yousfi *et al*. (2009).

The total phenolics and some individual phenolics, such as gallic, chlorogenic, ellagic, sinapic and protocatechuic acid, (+)-catechin and juglone were detected in *Pistacia atlantica* (Jouki and Khazaei, 2010). The phenolic contents of the leaves of *Pistacia lentisicus* (mastic tree) and *Pistacia atlantica* (Mount Atlas pistache) were approximately 1.96 ± 0.70 and 0.9 ± 0.05 mg g^{-1} respectively (Benhammou *et al*., 2007).

Other Constituents

Quinic acid was isolated from young leaves of *Pistacia atlantica*, and shikimic acids from both young and mature leaves (Plouvier, 1960). A steroidal alkaloid, pistacimidelor (3β-dimethylamino-con-2-enin-18-one-19β,22β-dimethyl) was identified from the leaves of *Pistacia atlantica* subsp. *mutica* of Iranian origin (Meshkatalsadat *et al.*, 2007). The seeds contain inositol hexaphosphate P 176 mg% (Courtois and Pérez, 1948).