



Università degli Studi di Napoli *Federico II*  
*Dipartimento di Farmacia*



3<sup>rd</sup> International Conference and Exhibition on  
**Probiotics, Functional and Baby Foods**

September 23-25, 2014 Hotel Royal Continental, Naples, Italy

**Nutraceutical potential of artichoke  
(*Cynara scolymus*) edible and waste portions**

***25 September 2014***

***Prof. Dr. H.c. Alberto Ritieni***

Prof. Dr. H.c. *Alberto Ritieni*

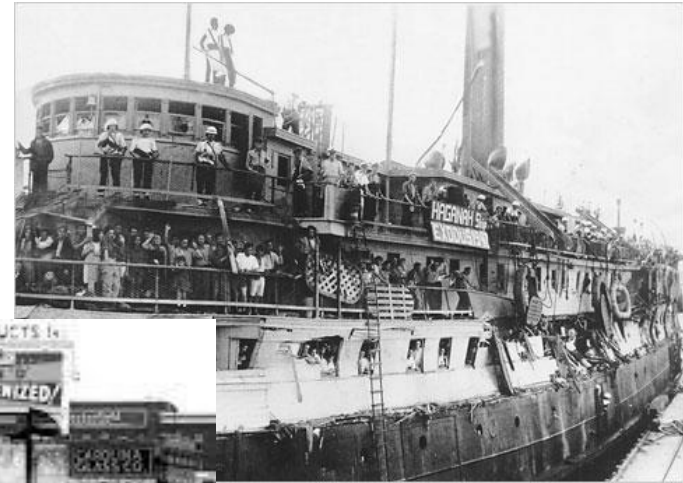
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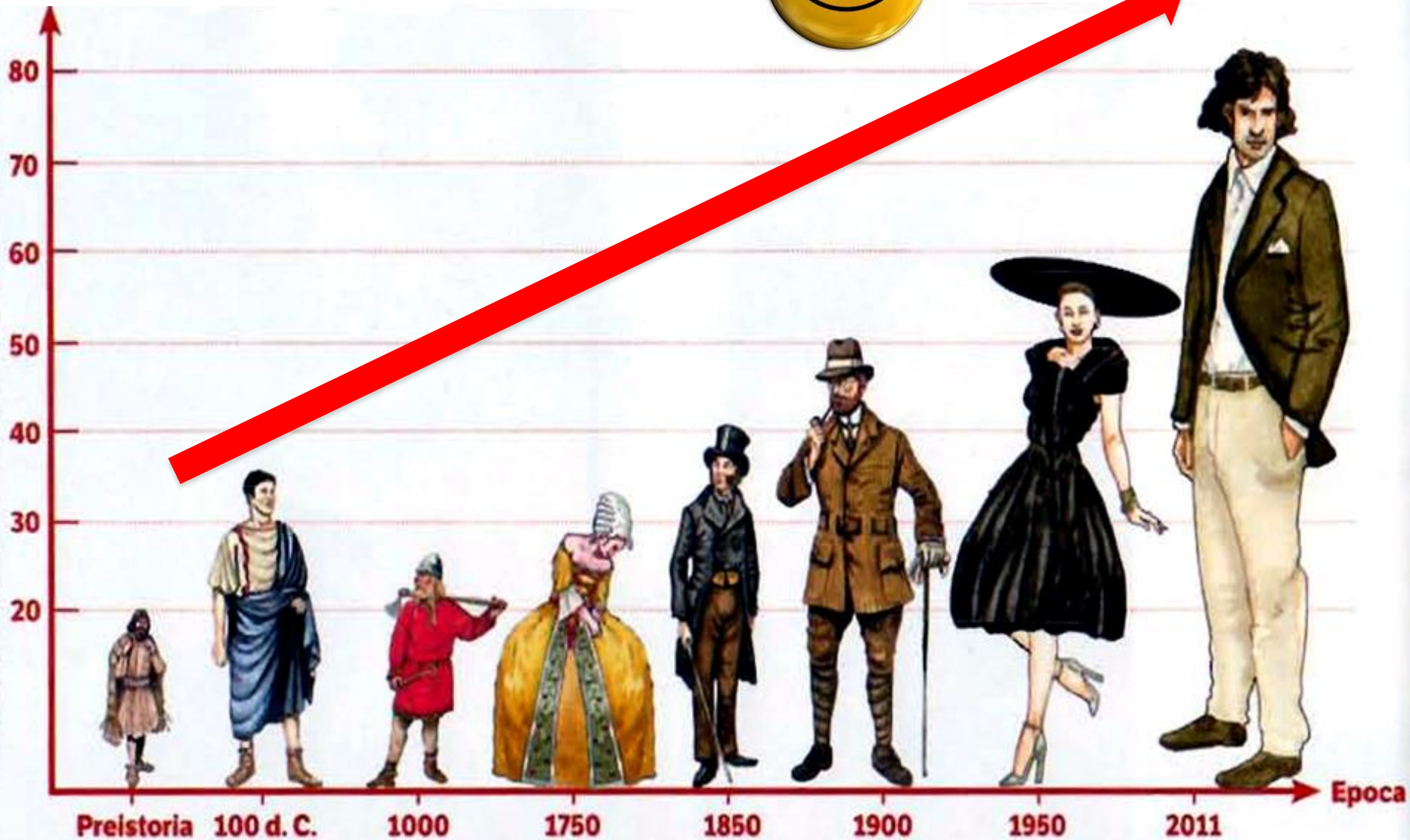
“Health is a state of **complete**  
physical, mental and social,  
and **not merely the absence of**  
**disease**”

*(OMS, 1947)*



# How has lengthened the average life of industrialized populations?

Life expectancy in years





**“Health is a state of **complete** physical, mental and social, and **not** merely the absence of disease...**



+

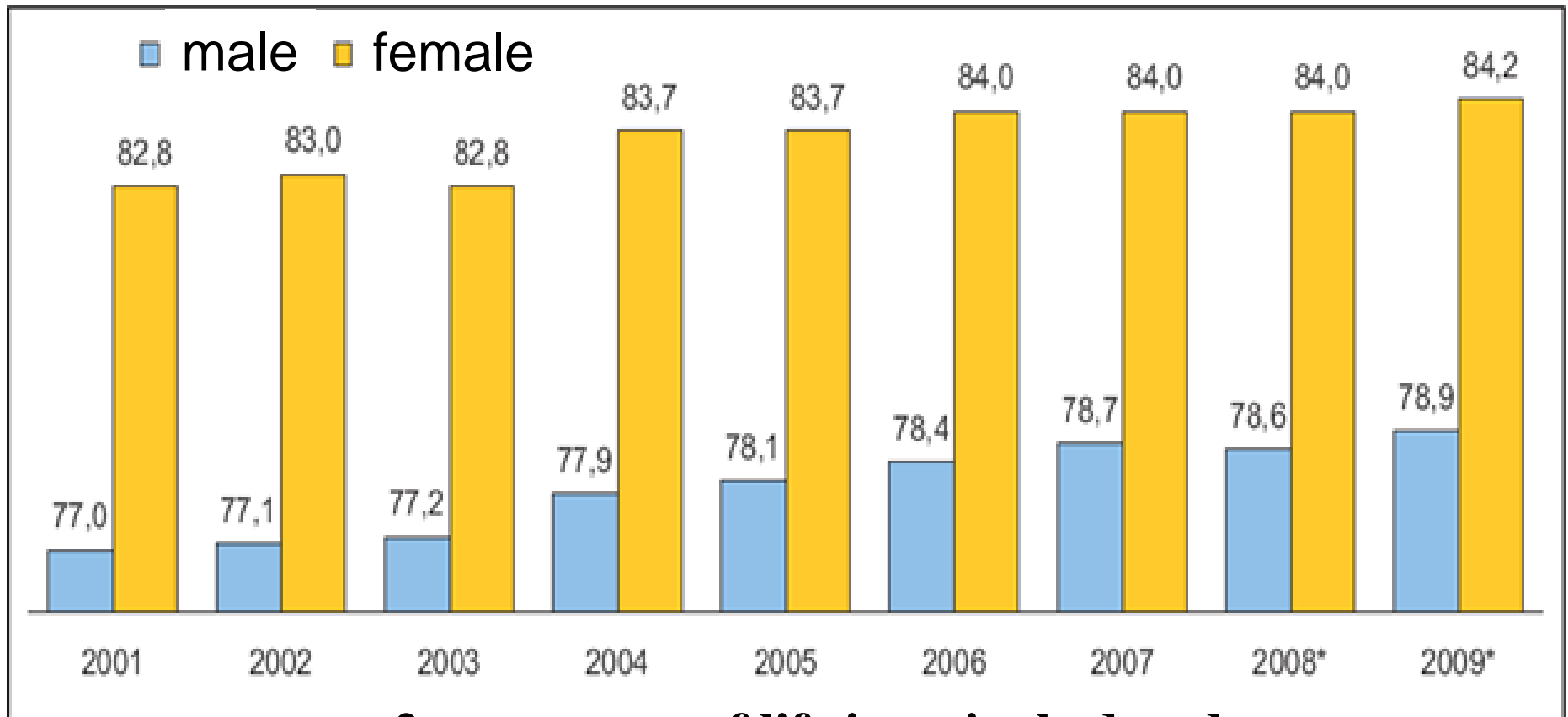


*...the maintenance of the state of well-being and pleasure to be nice and accept”*

# Current Scenario

**61.3% of the population claims to be in good health**

Speranza di vita alla nascita per sesso in Italia, 2001-2009



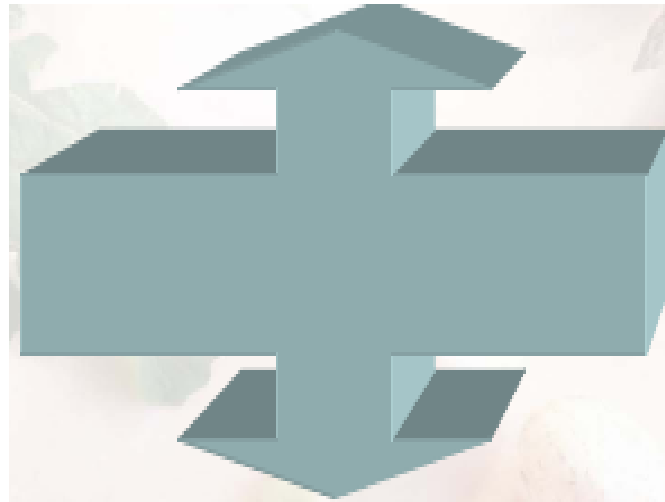
**2 years more of life in a single decade**

\* stima

The solution isn't to “*add years to life*” but is important to “*add life and quality to years*”



Life expectancy



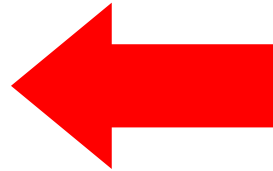
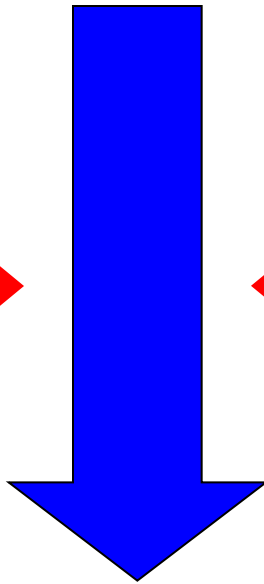
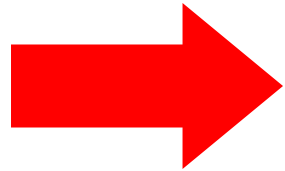
Life quality



# How to prevent diseases ?????

**DNA capital from parents**

**Surgical  
emergency**



**Environment  
Lifestyles  
(*Nutrition*)**

**Health Status**

# Innovative Pharmacotherapy

## Lifestyle drugs

*...drugs for health people*

Suggested for the treatment of risk factors that result from improper lifestyles or conditions **NOT ONLY** pathological that produce restrictions on the welfare of persons



# How to prevent disease ????

## Drugs



Expect the expression  
of the disease

## Nutraceuticals



Phase of the attack  
is the best defense

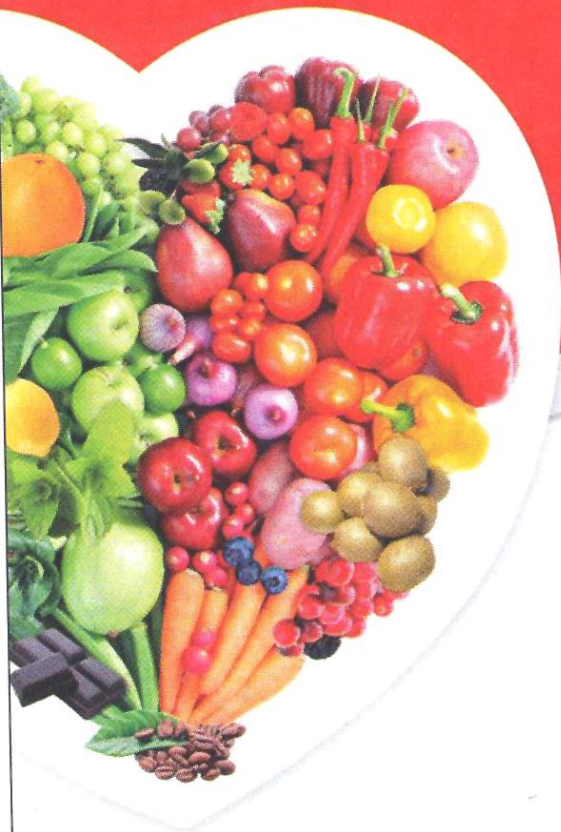
# FUNCTIONAL FOOD AND NUTRACEUTICALS





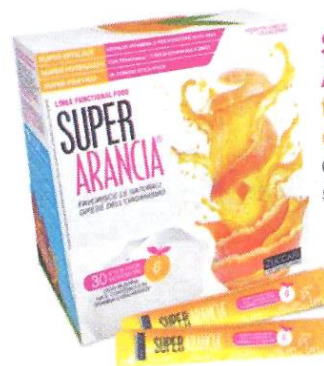
# FUNCTIONAL FOOD

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# FUNCTIONAL FOODS

Foods characterized by *additional effects due to the presence of components naturally present or added which interact more or less selectively with one or more physiological functions of the organism*, leading to **positive effects on the maintenance of health and / or prevention of diseases.**



# Dietary Supplements

Foods that supplement the diet and are formulated with vitamins and minerals, or other substances with nutritional and / or physiological effects. Include: amino acids, essential fatty acids, fiber and plant-derived extracts and can be dosed alone or in combination.





# Nutraceutical



It was in **Rome** that in **1989** **Stephen De Felice**, medical, founder and President of the *Foundation for Innovation in Medicine* coined the term **nutraceutical** by "**nutrition**" and "**pharmaceutical**"

*According to the original definition, the nutraceutical may be considered, "a food (or part of the food), which gives beneficial effects to health (principle medicated), including the prevention and / or treatment of a disease "*



**Food supplements**

**Functional Food**



# Nutraceutical

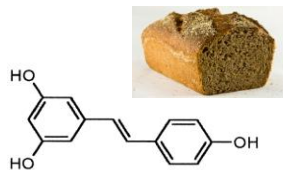
**“drug and food”**

**“beyond diet, before drug”**

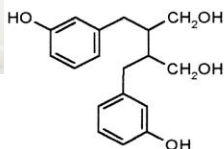
# Chemical composition and nutritional asset of several vegetables (100 g)

Ortaggi e verdure	Parte edibile %	Acqua g	Proteine g	Lipid g	Glicidi disponibili g	Fiber g	Energia kcal	Sodium mg	Kalium mg	Ferro mg	Calcium mg	Phosphorus mg	Tiamina mg	Riboflavina mg	Niacina mg	Vitamina A µg	Carotenoids µg	Vitamin C mg
<b>Garlic</b>	75	80,0	0,9	0,6	8,4	—	41	—	—	1,5	14	63	0,14	0,02	1,3	0	30	5
Bieta	82	94,5	1,3	0,1	2,8	1,2	17	—	—	1,0	67	29	0,03	0,19	1,8	0	1578	24
<b>Artichoke</b>	34	84,0	2,7	0,2	2,5	5,5	22	133	376	1,0	86	67	0,06	0,10	0,5	0	108	12
Carote	95	91,6	1,1	0	7,6	3,1	33	95	220	0,7	44	37	0,04	0,04	0,7	0	6888	4
Cicoria	80	93,4	1,4	0,2	0,7	3,6	10	—	—	0,7	74	31	0,03	0,19	0,3	0	1314	17
<b>Onion</b>	83	92,1	1,0	0,1	5,7	1,1	26	10	140	0,4	25	35	0,02	0,03	0,5	0	0	5
Finocchi	59	93,2	1,2	0	1,0	2,2	9	—	—	0,4	45	39	0,02	0,04	0,5	0	12	12
Funghi (porcini)	92	92,0	3,9	0,7	—	2,5	22	52	235	1,2	22	142	0,38	0,26	4,0	0	0	3
Melanzane	92	92,7	1,1	0,1	2,6	2,6	15	26	184	0,3	14	33	0,05	0,05	0,6	0	17	5
<b>Potato</b>	83	78,5	2,1	1,0	18,0	1,6	85	7	570	0,6	10	54	0,10	0,04	2,5	0	18	15
Peperoni	82	92,3	0,9	0,3	4,2	1,9	22	2	210	0,7	17	28	0,05	0,07	0,5	0	834	151
<b>Tomato</b>	100	94,0	1,0	0,2	3,5	0,9	19	6	297	0,3	9	25	0,02	tr	0,8	0	810	25
Prezzemolo	80	87,2	3,7	0,6	tr	5,6	20	20	670	4,2	220	75	0,10	0,21	0,6	0	7000	162
Sedano	80	88,3	2,3	0,2	2,4	1,6	20	10	280	0,5	31	45	0,06	0,19	0,2	0	1242	32
Zucca gialla	81	94,6	1,1	0,1	3,5	—	18	—	—	0,9	20	40	0,03	0,02	0,5	0	3594	9
Zucchine	88	93,6	1,3	0,1	1,4	1,3	11	—	—	0,5	21	65	0,08	0,12	0,7	0	373	11

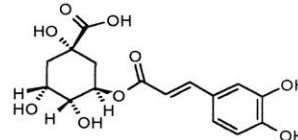
# Simple phenols and oligomers isolated by food sources



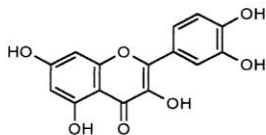
resveratrol  
(stilbene)



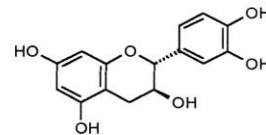
enterodiol  
(lignan)



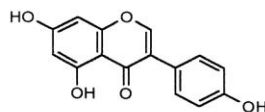
chlorogenic acid  
(phenolic acid)



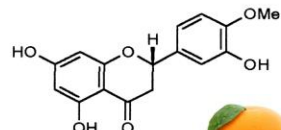
quercetin  
(flavonol)



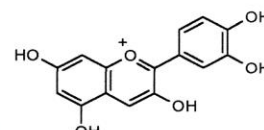
(+)-catechin  
(flavanol)



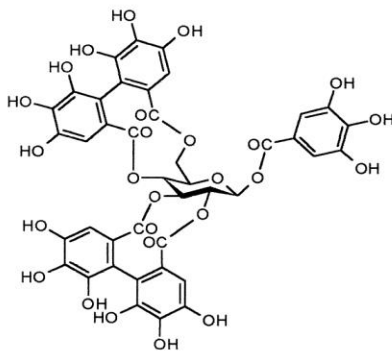
genistein  
(isoflavone)



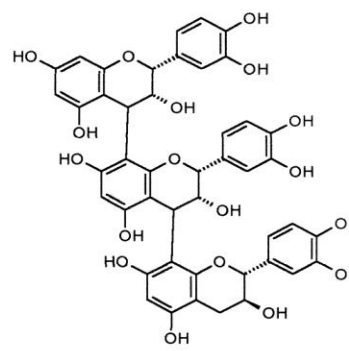
hesperetin  
(flavanone)



cyanidin  
(anthocyanidin)



casuarictin  
(ellagitannin)



procyanidin trimer  
(flavanol)



# Artichoke

- **The artichoke (*Cynara scolimus* L.) belongs to the family of *Astraceae*, a former family *Compositae*.**
- **The genus is most interesting is the *Cynara* which includes eight wild species all originating from the Mediterranean basin discoveries in the fifteenth and sixteenth centuries.**

**It is a rhizomatous herbaceous plant which has an inflorescence is protected by bracts which, together with the basal portion, tender, are the edible part**





# Artichoke

- In Italy there are **50,000 hectares cultivated** and are produced over **500,000 tonnes** (40% of world production).
- Italy is the first country in the world producer of artichokes
- Apulia is the first Region in Italy **36,3%** of hectars, **Sicily (28,4%)**, Sardinia (21,4%), **Campania (5,6%)**, Lazio (2,5%) and **Tuscan (2%)**

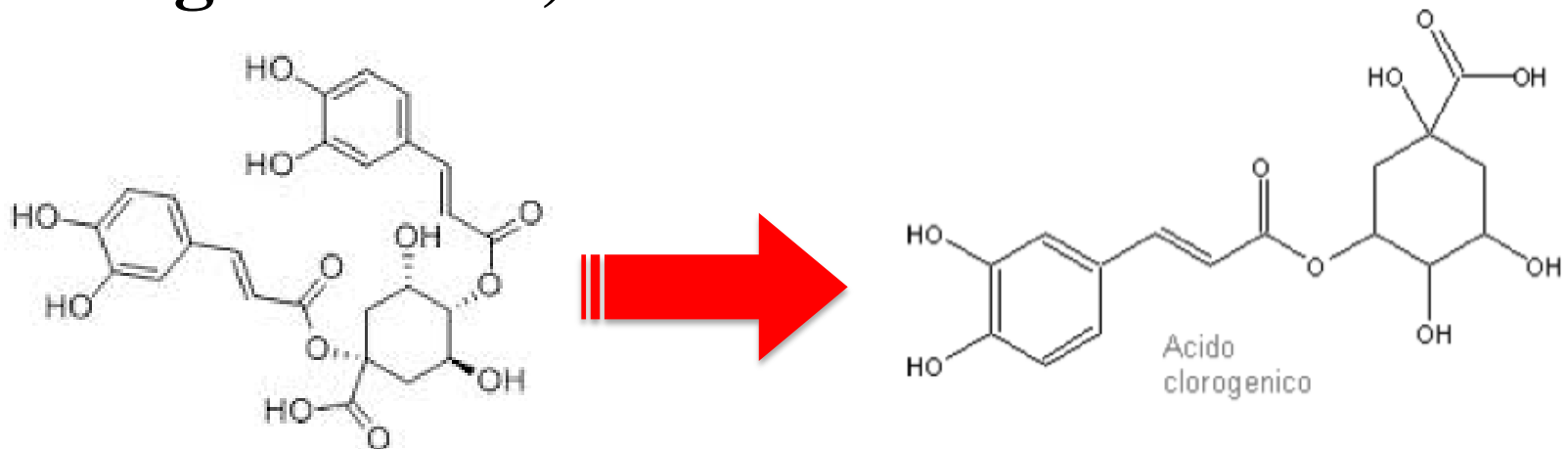


# Artichoke and Nutrients

<b>Water</b>	<b>86%</b>
<b>Proteins</b>	<b>2%</b>
<b>Lipids</b>	<b>0.2</b>
<b>Glucids</b>	<b>12.5%</b>
<b>Soluble (glucose)</b>	<b>2.0</b>
<b>Energy</b>	<b>42 kcal</b>
<b>Vitamins</b>	<b>B<sub>1</sub>, B<sub>2</sub>, PP</b>
<b>Mineral Salts</b>	<b>K<sup>+</sup>, Na<sup>+</sup>, Ca<sup>2+</sup> Fe<sup>3+</sup></b>

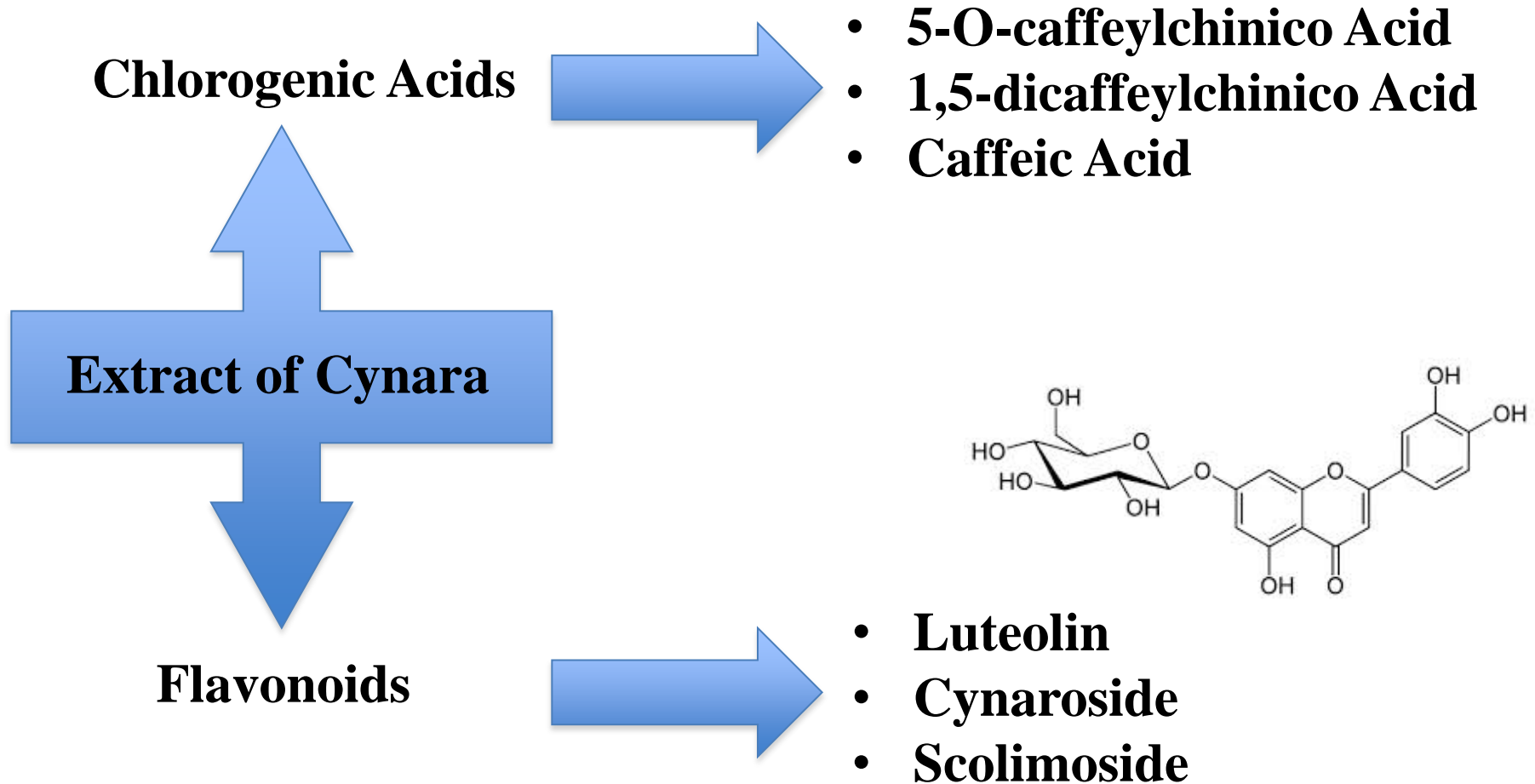
# Artichoke and Bioactive Metabolites

- From artichoke have been isolated a large group of polyphenols. The main components are **Chlorogenic Acid, Cynarin** and **Caffeic Acid** (obtained by hydrolysis of Cynarin and Chlorogenic Acid)



**In the extracts are present numerous diphenols and bioactive flavanoids**

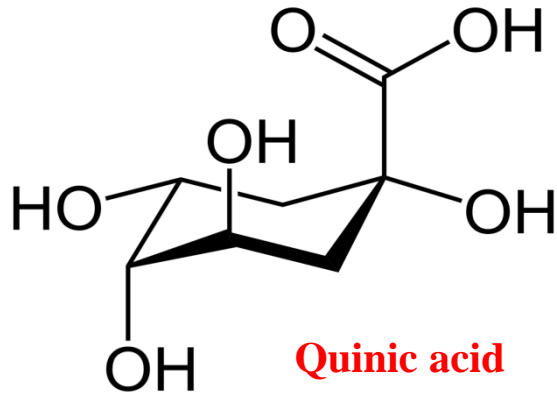
# Main bioactive compounds of Artichoke



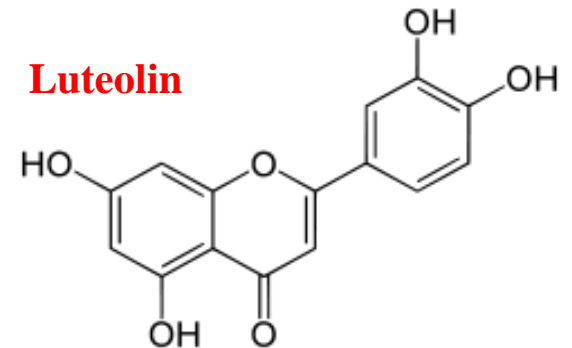
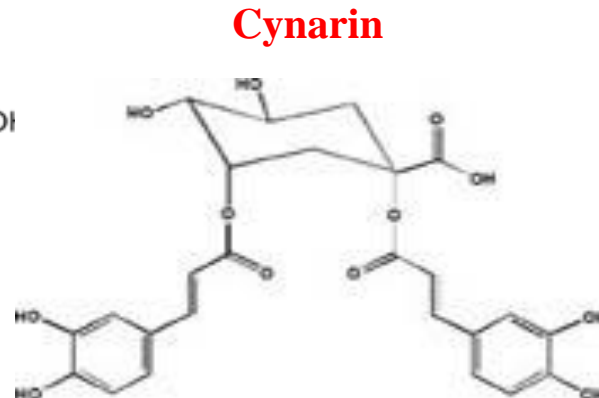
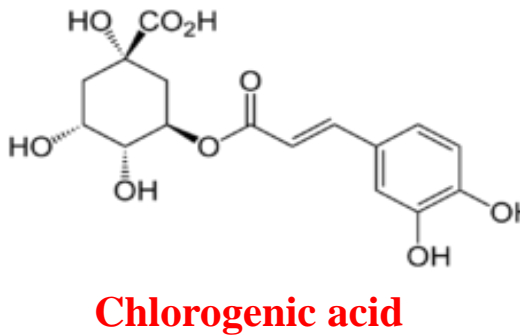
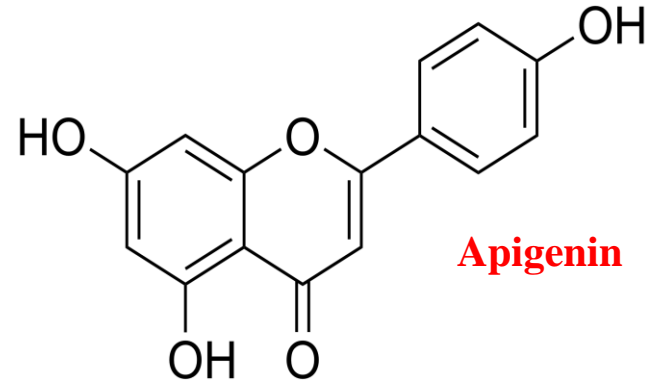


# POLYPHENOLIC COMPOUNDS

## HYDOXYCINNAMATES



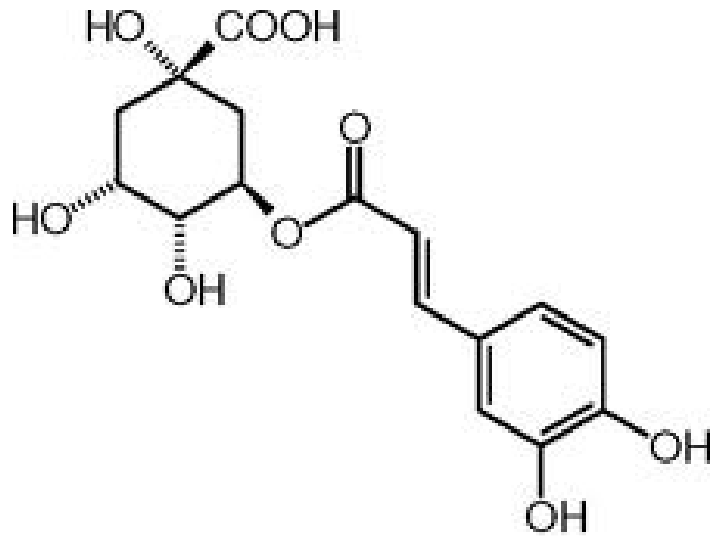
## FLAVONOIDS



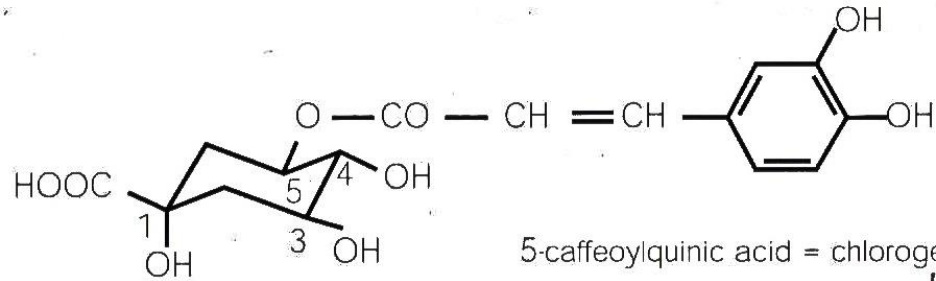
# Main bioactive compounds of Artichoke

<b>Amount of compounds in ppm</b>	<b>Hydrophilic extract</b>
<b>Chlorogenic Acid</b>	<b>262.7</b>
<b>Mono-caffeoylquinic Acid</b>	<b>496.0</b>
<b>Cynarin</b>	<b>42.0</b>
<b>Luteolin 7-O-rutinoside</b>	<b>47.9</b>
<b>Luteolin 7-O-glucoside</b>	<b>14.0</b>
<b>Luteolin 7-O-malonil glucoside</b>	<b>8.5</b>
<b>Luteolin</b>	<b>2.9</b>
<b>Di-caffeoylquinico</b>	<b>46.0</b>
<b>Polyphenols Total</b>	<b>920.7</b>

# Chlorogenic Acid



**Chlorogenic Acid**



5-caffeoylquinic acid = chlorogenic acid

3-caffeoylquinic acid = neochlorogenic acid

3,4-di caffeoylquinic acid

3,5-di caffeoylquinic acid

4,5-di caffeoylquinic acid

5-feruloylquinic acid

4-feruloylquinic acid

3-feruloylquinic acid

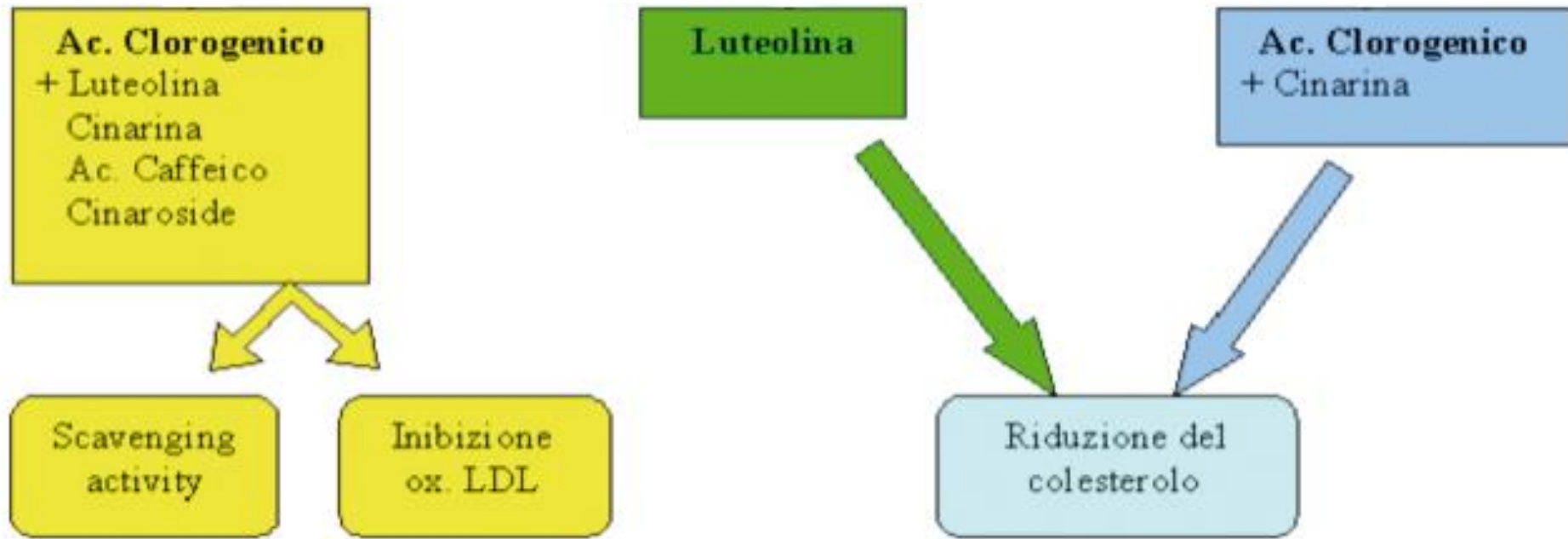
# Potential Nutraceutical activities of Artichoke's extracts

They marked *in vitro* and *in vivo* **hepatoprotective** effects, **choleretic** and **hypocholesterolemic**

In '900 scientific research focuses on the properties "**hepato stimulant**" leaf extracts of Cynara, advocated by doctors' 700.



# Main mode of actions of the extracts of *Cynara scolymus*





# Antioxidant Activity

The dry extract of leaves of artichoke protects the liver from damage caused by hepatotoxic  $\text{CCl}_4$  as the hydroxide, cumene and tert-butyl-hydroperoxide

The components which perform the antioxidant are the phenolic acids like: Cynarin and Caffeic acid



# Nutraceutical Potential Power

- **Antioxidant Power**
- **Antimicrobial Activity**
- **Cell Tests: antitumoral activity, potential hypoglycemic, lipid-lowering potential**
- **Bioaccessibility and bioavailability**

# Potential activities of *Cynara Scolymus*



## Hepatoprotective

TOMASA DZET, JORGE CAMARASA, and JUAN CARLOS AGUNA+

## Antifungal

Zhu, X. F., Zhang, H. X., & Lo, R. (2005)

## Anti-HIV

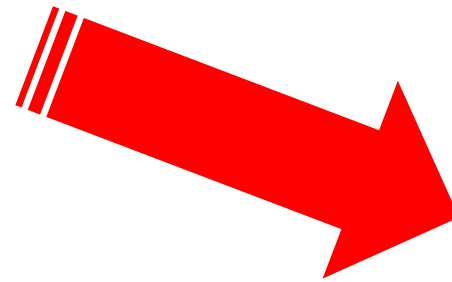
McDougall, B., King, P. J., Wu, B. W., Hostomsky, Z., Manfred, G., & Robinson, W. E. Jr., (1998)

## Antioxidant Source

Brown, J. E.; Rice-Evans, C.

## Anticarcinogeni

Michael N Clifford



## Antibacterial

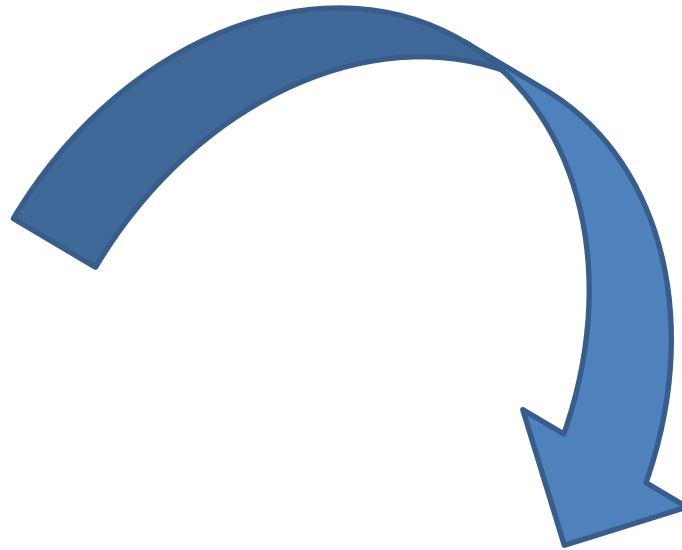
## anti-inflammatory

## Diuretic

## CHOLESTEROL-LOWERING AND HYPOGLYCEMIC

Clifford, M.; Walker, R.  
Heidarian, Esfandiari; Soofiniya, Yadollah

# Artichoke *by-products*



**Very reach sources  
or bioactive  
metabolites**

# Quali-quantitative analysis of Artichoke extracts

1. Extraction of samples with different protocols
2. Purification of bioactive metabolites by HPLC, MPLC, etc.
3. Chemical Identification of bioactive metabolites by mass spectrometry, NMR etc.



**Relative pure extracts**

# Chlorogenic Acid Quantification

Artichoke	mg AC/100 g
<i>Romolo stem</i>	27,826
<i>Romolo heads</i>	6,276
<i>Romolo leaves</i>	0,5

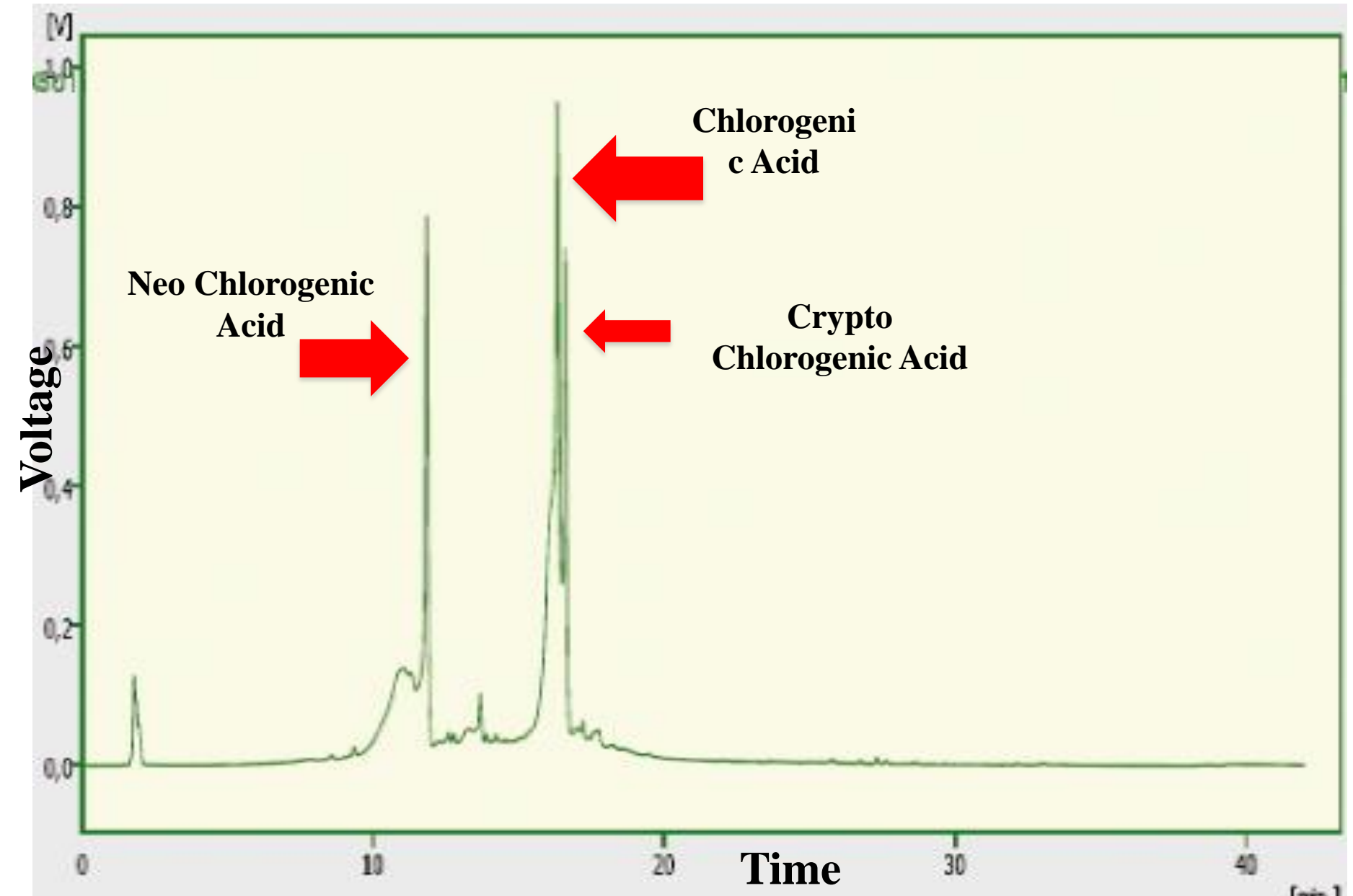


## Antioxidant Activity Evaluation

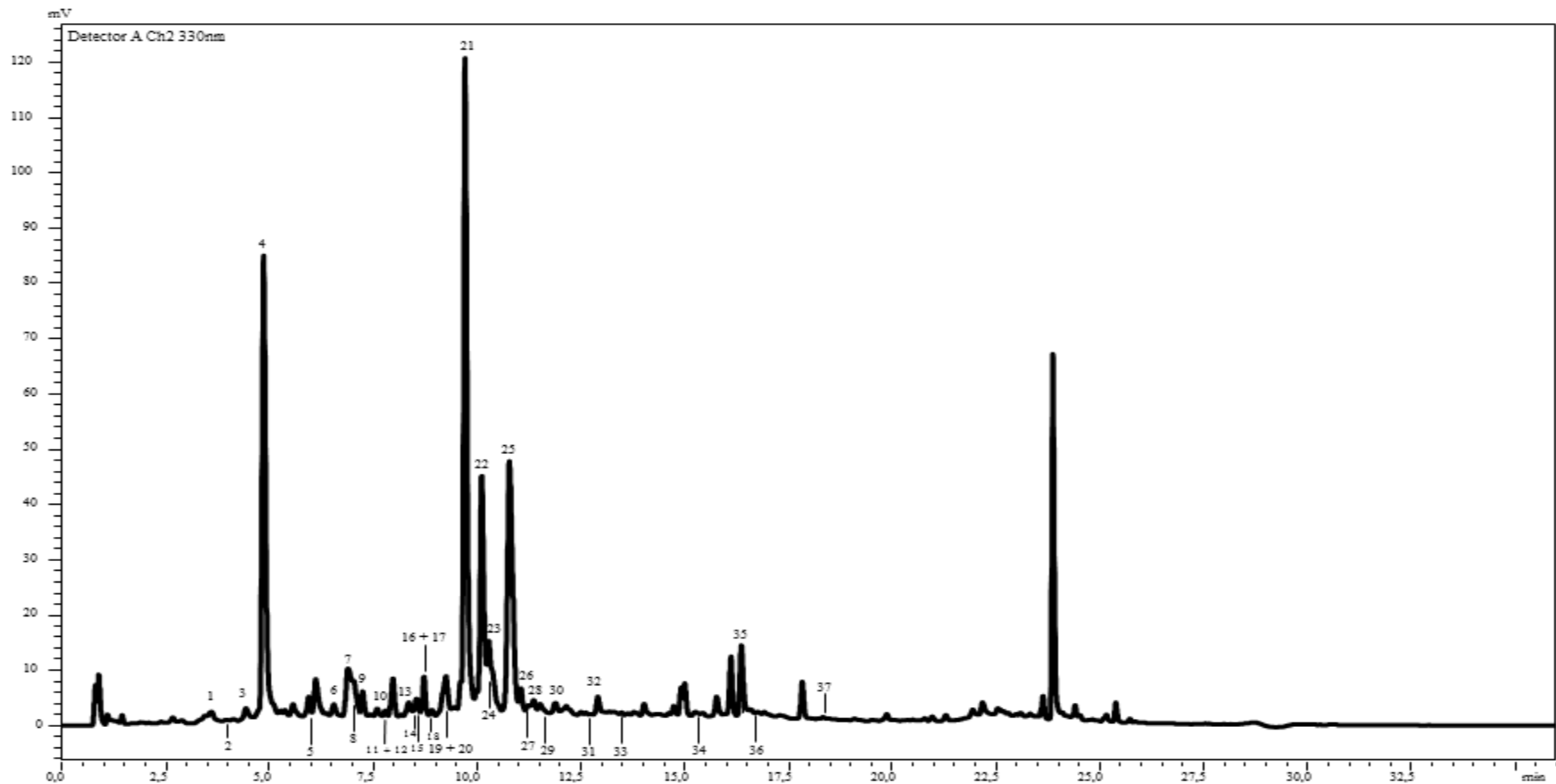
Artichoke	Total Phenols Content mg AGE/100 g	DPPH $\mu\text{molTE}/100\text{ g}$	FRAP $\mu\text{molTE}/100\text{ g}$
<i>Romolo stem</i>	21,35	78,61	104,46
<i>Romolo heads</i>	4,53	38,95	24
<i>Romolo leaves</i>	26,44	124,47	64,54



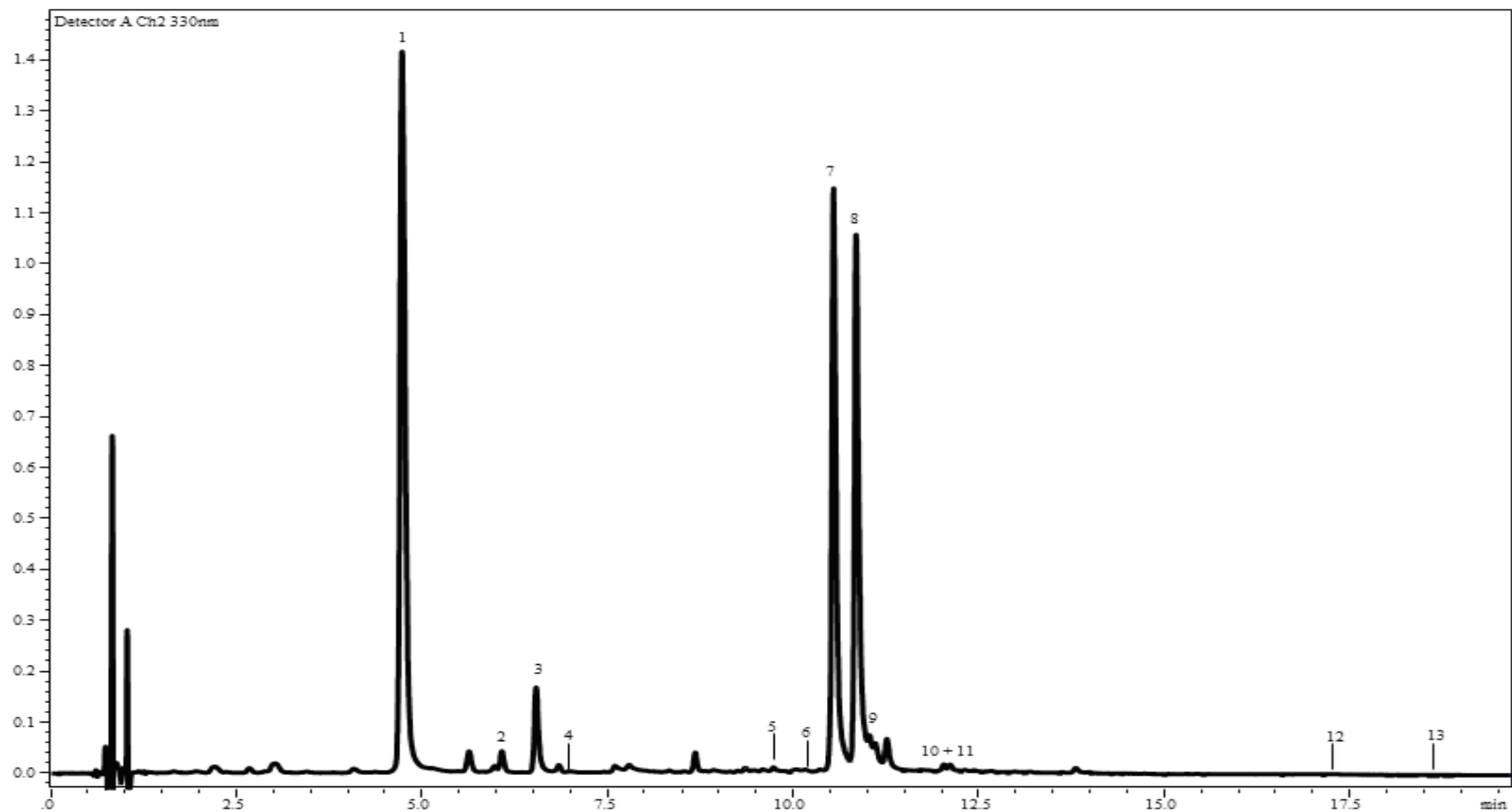
# HPLC run of the extract of Artichoke





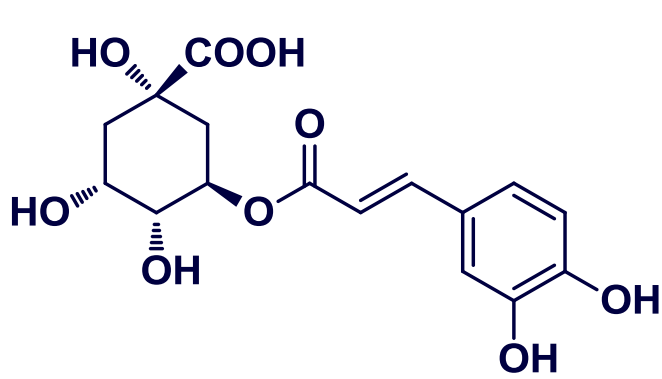


**UHPLC-PDA** chromatogram of *Cynara Scolymus* heads polyphenolic extract . Peaks identified are: (1): Syringic acid O-hexoside; (2): Trihydroxyoctadecenoic acid; (3): Dicafeoylquinic acid; (4): Monocaffeoylquinic Acid; (5): Propadienoic acid;(6): Dicafeoylquinic acid (isomer I); (7): Apigenin-7-O-glucoside; (8): Propadienoic acid; (9): p-Coumarylglucoside; (10): Apigenin-7-O-cinnamoylglucoside; (11): 1-Hydroxypinoresinol 1-o- $\beta$ -D-glucoside; (12): Unknown; (13): 3-O-Feruloylquinic acid; (14): 3-O-Feruloylquinic acid (isomer); (15): Lusitanicoside (chavicol  $\beta$  rutinoside); (16): Luteolin-7-O-glucoside (Cynaroside); (17): Isorhamnetin 3-o-rhamnoside; (18): Lusitanicoside(Chavicol  $\beta$ -rutinoside) (isomer); (19) :Unknown; (20): Pinoresinol-4-O  $\beta$ -glucoside; (21): Dicafeoylquinic acid (isomer II); (22): Dicafeoylquinic acid (isomer III); (23): Isorhoifolin (Apigenin-7-O-rutinoside); (24): Isoquercitrin; (25): Apigenin-7-O-glucuronide; (26): Apigenin-7-O-glucoside (isomer); (27): Luteolin-7-O-rutinoside (scolymoside); (28): Kaempferol 3-o-acetyl glucoside; (29): Pinoresinol-acetylhexoside; (30): Apigenin-7-O-glucuronide (isomer); (31): Diferuloylquinic acid; (32): Apigenin-7-O-(6'acetyl)glucoside; (33): Luteolin; (34): Hydroxy-octadecatrienoic acid; (35): Apigenin; (36): Dihydroxypropionhend-hexoside; (37): Trihydroxyoctadecenoic acid.

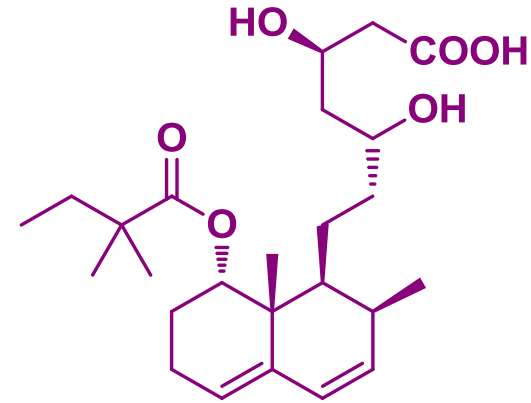
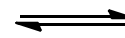
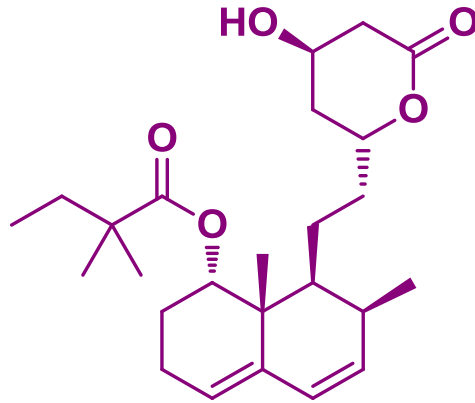


**UHPLC-PDA** chromatogram of *Cynara Scolymus* stems polyphenolic extract. Peaks identified are: **(1)**: Monocaffeoylquinic acid ; **(2)**: Monocaffeoylquinic acid (isomer); **(3)**: 3-p-Coumaroylquinic acid; **(4)**: p-Coumaroylquinic acid; **(5)**: Luteolin-7-O-rutinoside (scolymoside); **(6)**: Luteolin-7-O-glucoside; **(7)**: Dicafeoylquinic acid; **(8)**: Dicafeoylquinic acid (isomer I); **(9)**: Dicafeoylquinic acid (isomer); **(10)**: 3-p-Coumaroyl-4-cafeoylquinic acid; **(11)**: 3-p-Coumaroyl-4-cafeoylquinic acid (isomer); **(12)**: Dihydroxypropionhexoside; **(13)**: Trihydroxyoctadecenoic acid.

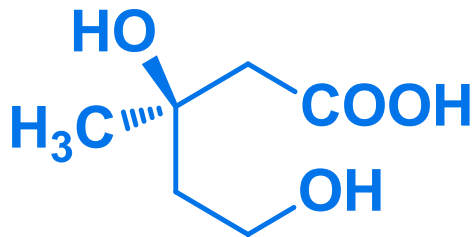
# Chlorogenic Acid vs Statins



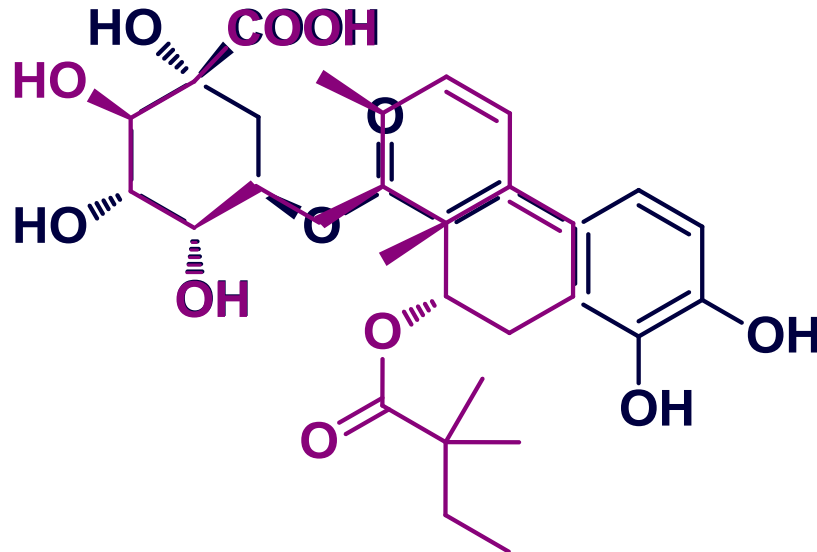
**Chlorogenic Acid**



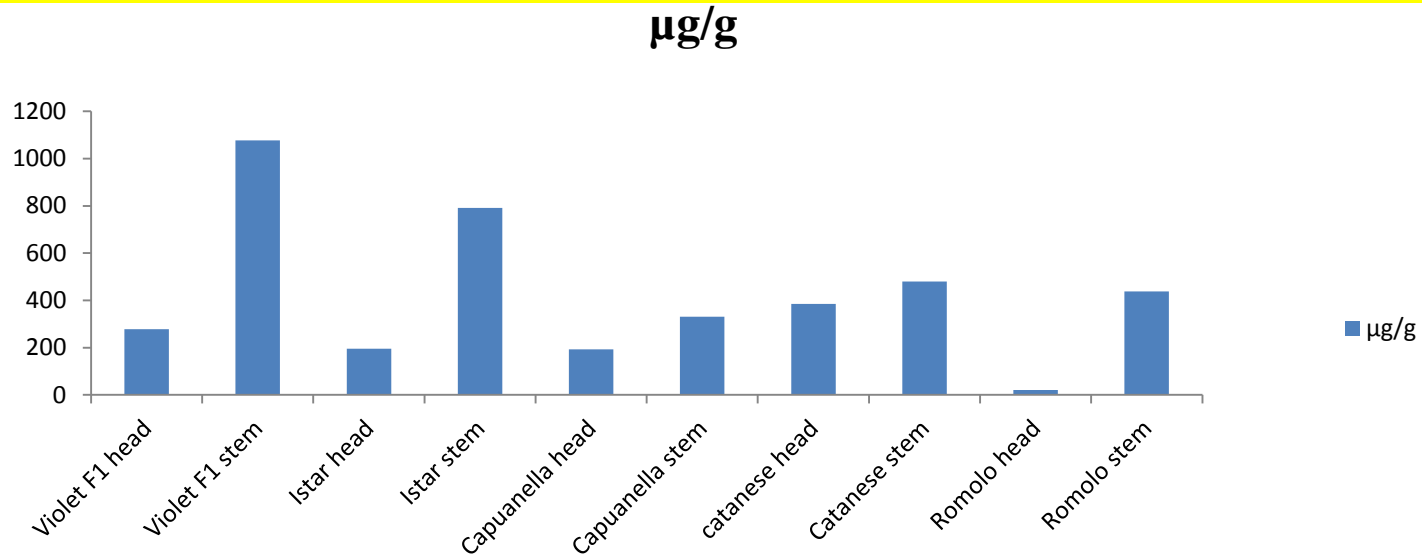
**Simvastatin**



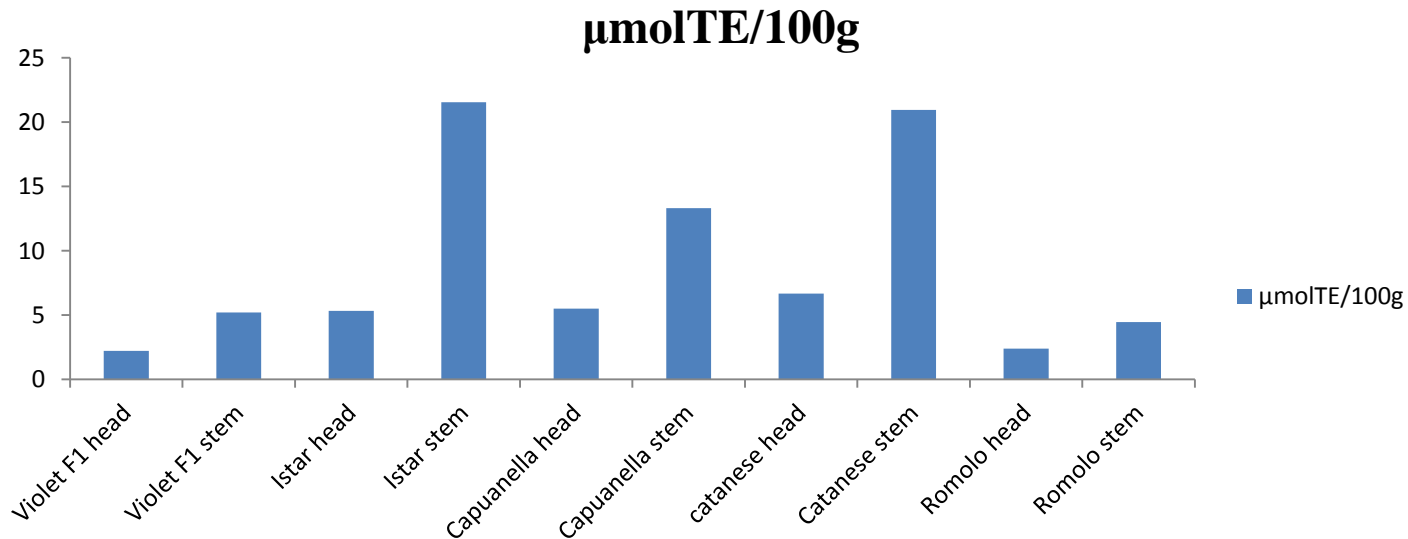
**Mevalonic acid**



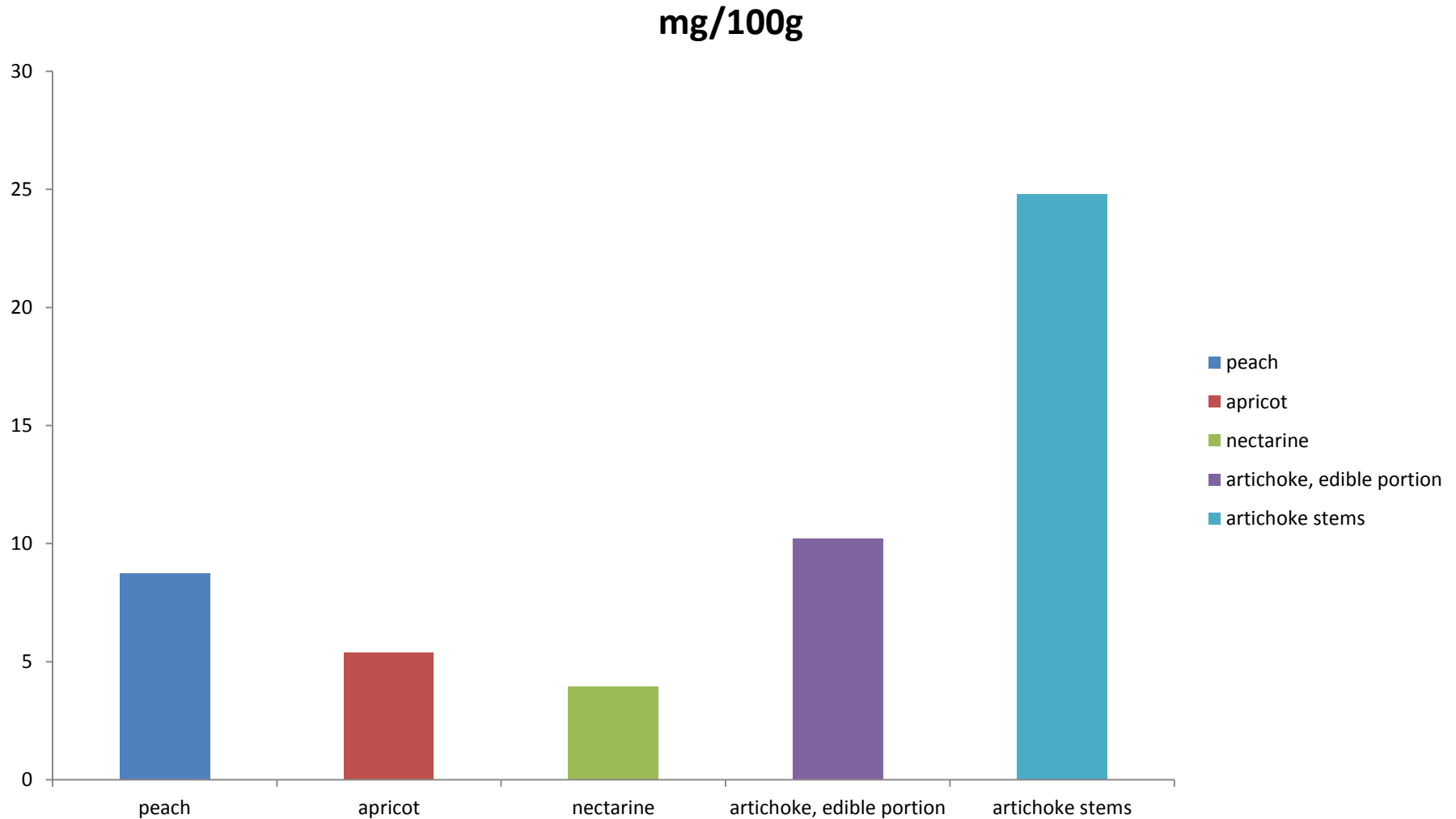
# Hydroxycinnamates amount and...



# Antioxidant activity



# Chlorogenic acid: Artichoke vs other vegetables



# Artichoke Nutraceutical Market



## IL CARCIOFO DI LAON

La prima capsula al  
carciofo di Laon  
iper-concentrata per dimagrire



# Artichoke Nutraceutical Market

Scoprite come funziona il carciofo iperconcentrato



Per aiutarvi a perdere peso, il Carciofo di Laon è (di gran lunga) il solo ortaggio che contiene una così alta quantità di cinarina, inulina e polifenoli. Queste sostanze iperattive agiscono su 7 livelli del vostro metabolismo per aiutarvi a lottare contemporaneamente contro i vostri chili di troppo e combattere la vostra cellulite.

Questa dimostra che **Carcioforte** è un vero distruttore di grassi, il migliore mai offerto a tutti coloro che soffrono a causa dei chili di troppo e per i quali prima nulla aveva funzionato.



Una concentrazione incredibile

Sì, non si tratta di un errore: ogni capsula di Carcioforte ha un contenuto 6 volte maggiore di carciofo di Laon, rispetto agli "Shot" mostrati in televisione o sulle riviste.

Quindi apporterete al vostro organismo un quantitativo sei volte superiore di cinarina, flavonoidi, inulina, polifenoli, luteina, e niacina per poter perdere finalmente tutti i vostri chili in più e la vostra cellulite.

Avrete a disposizione un vero esercito di enzimi e di agenti anti-grasso che lavoreranno per voi senza che ve ne rendiate conto.





# Conclusion

The research demonstrates how one can get from the residues from the plant as a source of **nutraceutical molecules** that can be used in medicine initiative.

If you reached the ultimate goal, this will involve:

- Reduction of welfare costs;
- **Reducing the environmental impact of waste;**
- Stimulus to the primary producers to obtain high quality of vegetables;
- **Revaluation of agricultural land otherwise depressed.**

**Il Carciofo dal tenero cuore si vestì da guerriero,  
ispida edificò una piccola cupola, si mantenne  
all' asciutto sotto le sue squame...**



**The Artichoke by  
tender heart dressed  
as a warrior  
Shaggy built a small  
dome, remained dry  
under its scales ...**

PABLO NERUDA



*da "Ode al carciofo"*

**Thanks for your time and  
attention**

attention