dr hab. Ewelina Hallmann

Division of Organic Food

Nutritive value and the content of bioactive compounds in organic and conventional fruits and vegetables

Why organic farming?

❖ Plants in organic system are cultivated without artificial pesticides and readily available fertilizers

❖ Natural animals manures, compost and green manures are widely used, rotation of crops is rich. This leads to natural balance farm – environment.

❖ Organic farming created a new market for organic products, because modern consumer are looking for more safety and controlled foods.

❖ The knowledge about healthy nutrition habits among consumers is growing. **<u>There is a hypothesis telling that organic plants contain higher level of bioactive substances, e.g. antioxidants: phenols, vitamin C, anthocyanins, than conventional ones.</u>**

C/N balance theory (Carbon to Nitrogen)

In natural conditions when nitrogen (N) is readily available (conventional agriculture), plants would primarily make compounds with high N content, e.g. proteins, amino acids for growth and N-containing secondary metabolites such as alcaloids.

When N-availability is limiting for growth (organic agriculture), metabolism changes more towards carbon (C) containing compounds: sugars, starch, cellulose and non-N-containing secondary metabolites such as phenolic and terpenoids, some vitamins and carotenoids.

(Brandt and Molgaard 2001)

Theory GDBH (Growth Differentiation Balance Hypotesis)

Plant in any given situation will assess the resources available to it and optimize its investment in processes directed towards growth or differentiation, respectively.

Organically produced plant foods could be more health-promoting than conventional foods. This is due to the differences in management practices between organic and conventional farming:

•An activation of the plant defense mechanisms by excluding synthetic plant protection agents;

•An active soil life where plants and microbes interact exchanging certain metabolic compounds;

•A balanced mineral nutrient uptake where excess of easily available nutrients is avoided.

(Brandt and Molgaard 2001)

World of carotenoids

The World is full of colors – natural and artificial (created by man) pigments.

There are almost 700 pigments, which belong to carotenoids group. They give yellow, orange and red pigmentation for fruit and vegetables.

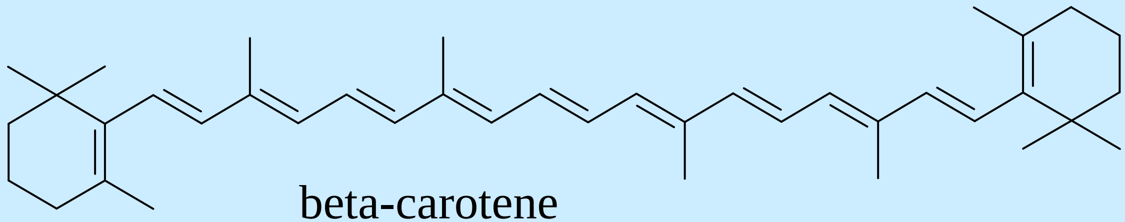
Carotenoids exist too in leafy vegetables, but they are covered by green pigment – chlorophyll. In autumn, when leaves stop producing chlorophyll, their color is changing into yellow, red and brown.

Within huge group of carotenoids beta – carotene is best know. It is pigment typical for orange, yellow and green – leafy vegetables. Lycopene gives red color for tomato fruit. Lutein and zeaxantin occur in corn.

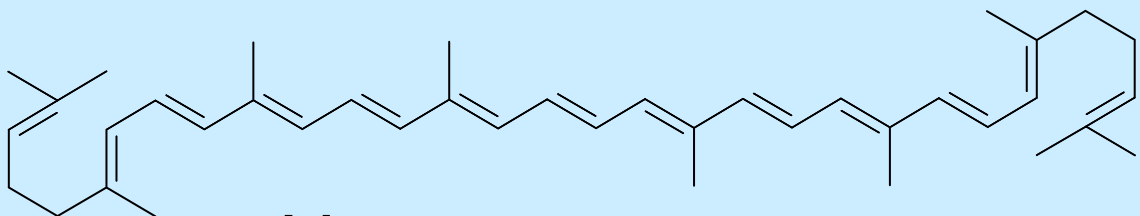
Carotenoids

Carotens (beta-carotene, alfa-carotene, sigma-carotene, lykopene, capsorubin)

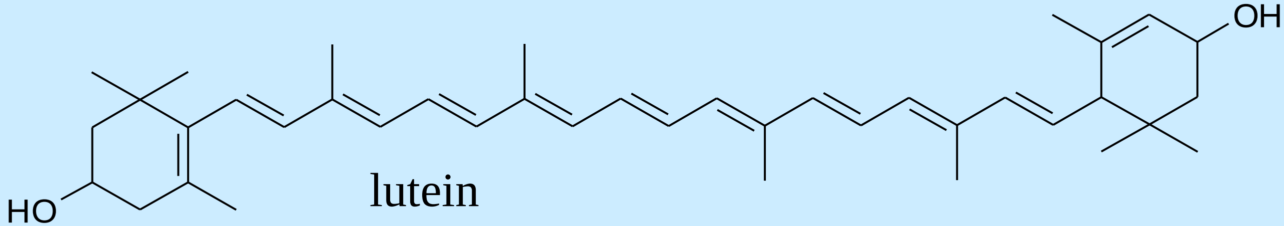
Xantophylles (zexanthin, lutein, neoxanthin, violaxanthin)



beta-carotene



lykopene



lutein

Profits of the carotenoids for human health

- They decrease level of cholesterol in blood and protect from coronary attak;

- There is experimental evidence that some carotenoids have anti-inflammatory properties;

- Because they are free radical scavengers, they are good antioxidants agents. They have anti - cancer properties;

- Beta – carotene protects human body against some kinds of skin cancer, occuring after UV radiation or toxic chemicals.

Epidemiogical studies involving carotenoids and chronic diseases (2009-2013)

The higher consumption of lycopene positively diminished bones cavity in osteoporosis suffer in group of 540 woman volunteers >75 age, but only in case of loin part of backbone. There was not observed any influence of lycopene in case of different part of backbone (Sahni et al. 2009).

There was not any correlation between consumption of leafy vegetables rich in beta-carotene and changing of variability of heart ECG in group of 580 men in >65 age (Park et al. 2013)

There was strong correlation between patent's age also lack of zeaxanthin in blood plasma and ARM symptoms (age-related maculopathy) (O'Connell et al. 2011).

SOURCES OF BETA – CAROTENE

- **yellow and orange vegetables :** carrot, pumpkin, yellow tomatoes, bellpepper
- **orange fruit**: apricots, peach, nectarine, melon, mango
- **green -leafy vegetables**: spinach, culiflower, broccoli, letuce, cichory, savoy cabbage, kale, beets lives, turnip, wild mustard, dandelion, endivie.

- **other fruit and vegetables**: green asparagus, green peas, sour cherry, dry fruits (apricot, peach)

SOURCES OF LYCOPENE

✸**red vegetables :** tomato, cherry tomato, bell pepper

✸ **fruit**: pink grapefruit, blood organe, apricot

✸**tomato products:** juice, ketchup, souce, dry tomato-soup, tomato concentrate

Epidemiogical studies involving lycopene, lycopene-containing foods and chronic diseases (1989-1999)

Disease	*Major conclusion*	*Reference*
Prostate cancer	**Intake of tomato products inversely associated with prostate cancer**	**Giovannucci et al. 1995, Clinton et al. 1996**
Digestive tract cancer	**Reduced risk with high tomato intake**	**Franceschi et al. 1994**
Bladder cancer	**Serum lycopene associated with decreased risk**	**Helzlsour et al. 1989**
Skin cancer	**Decrease on skin lycopene on exposure to light**	**Ribago – Mercado et al. 1995**
Breast cancer	**Serum lycopene associated with decreased risk**	**Dorgan et al. 1998**
Cervical cancer	**Lycopene level showed inverse risk**	**Sengupta and Das 1999**
Cardiovascular disease	**Adipose tissue lycopene associated with lower risk, low serum lycopene with increased mortality**	**Kohlmeier et al. 1997, Kristensen et al. 1997**

Bramley 2000

Tomato

Sweet bell pepper

Aubergine

Potatoes

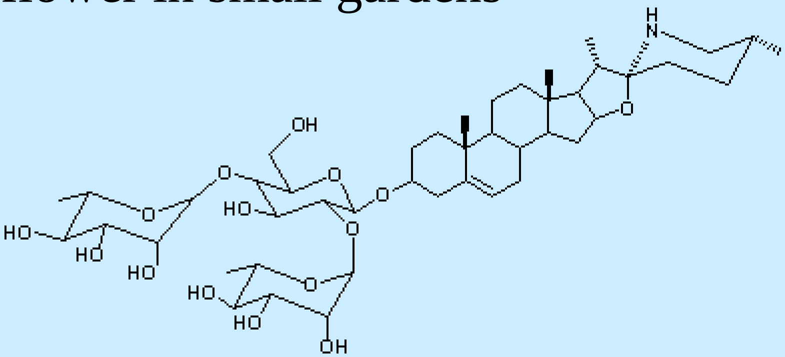
Cherry tomato

In polish language tomato is called „pomidor” it is come from italian Pomo d’oro (golden apple or apple of love)

The tomato country origins are Middle and South America, witch from it, was bring to Europe and very fast extend the new continents.

Funny story is that at the beginning it was treat as poison plant and was cultivated as a ornamental flower in small gardens

-tomatine, solanine



Today tomato is one from the most popular vegetables in the Word and integrated part of numerous international kitchen

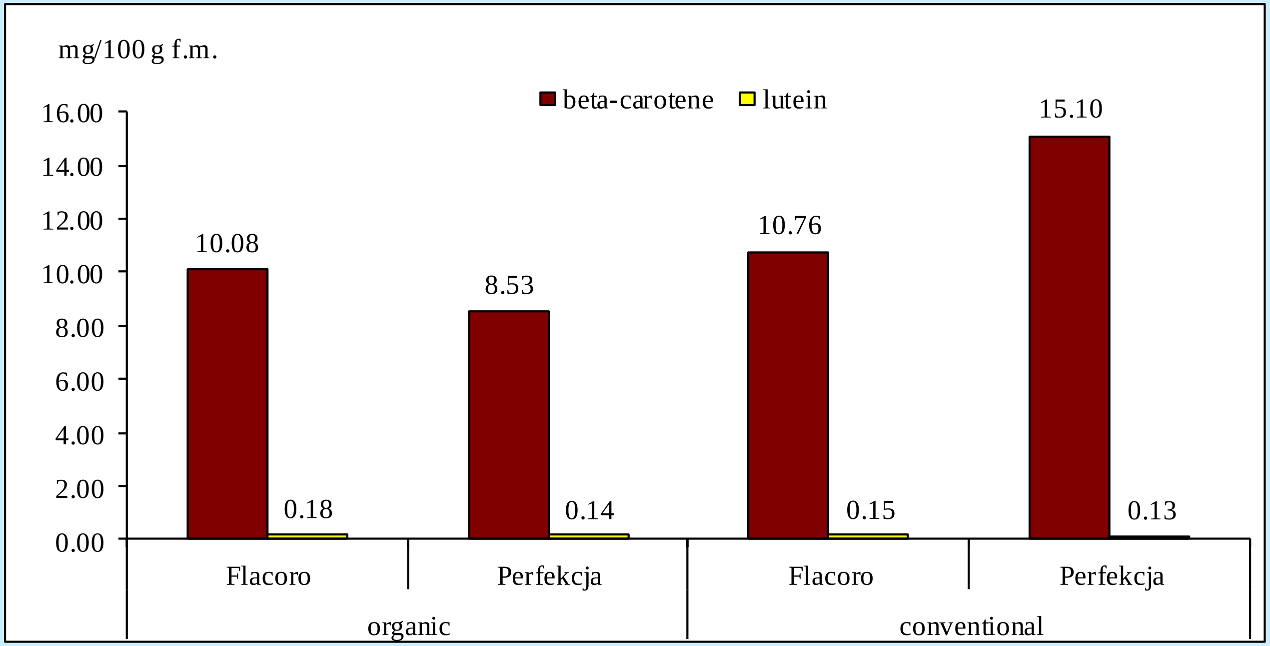
Some time it is seems that it is a symbol of countries as italian and spanisch kitchen

Compare of carotenoids content in vegetables from organic and conventional production

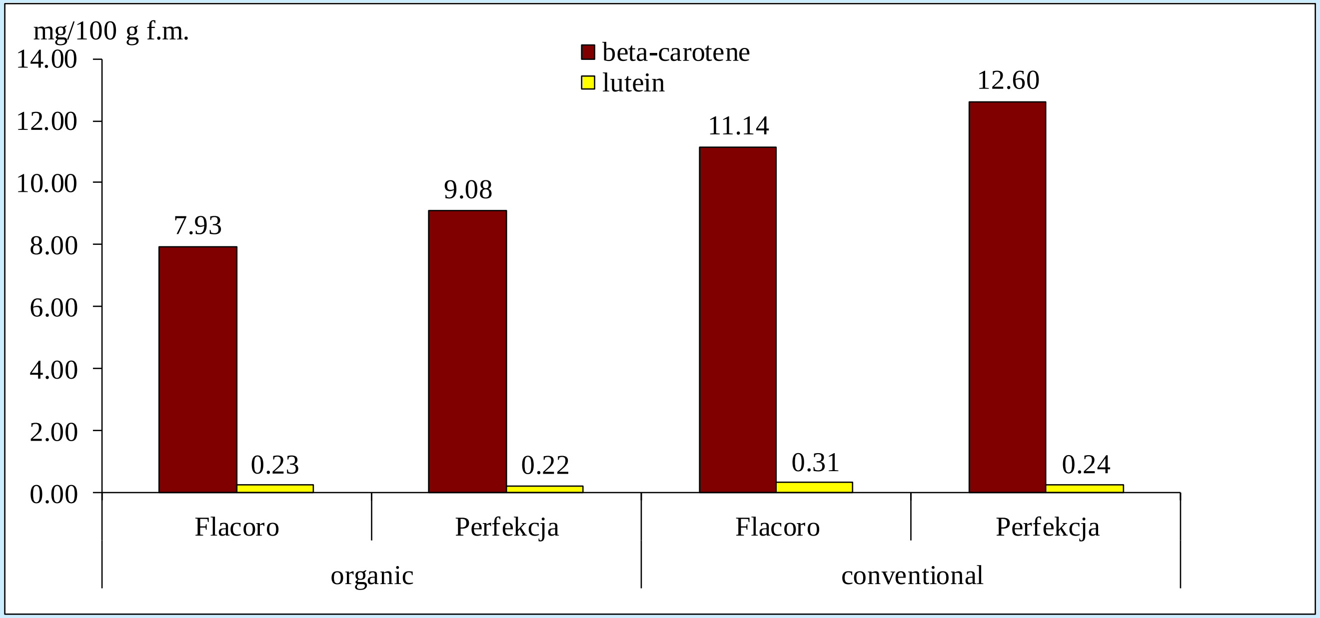
vegetables	compounds	difference in % org/conv	source
tomato	lycopene	+ 14.42	Caris-Veynard et. al. 2004
tomato	lycopene	- 13.59	Toor et al. 2006
tomato	lycopene	+ 0.31	Pieper and Barrett 2008
tomato	lycopene	+ 3.38	Juroszek et al 2009
		+1.13	
tomato	beta-carotene	+ 41.38	Caris-Veynard et. al. 2004
carrot	beta-carotene	-7.88	Warman and Havard 1997
carrot	beta-carotene	+2.84	Abele 1987
		+12.11	
red pepper	total carotenoids	+ 86.71	Pérez-López et al. 2007
		+86.71	

Organic vegetables contained more carotenoids Results obtained in Division of Organic Food (WULS)

vegetables	compounds	difference in % org/conv	source
tomato	lycopene	- 30.81	Rembiałkowska et al. 2005
tomato	lycopene	+ 22.03	Rembiałkowska et al. 2005a
tomato	lycopene	- 19.20	Hallmann and Rembiałkowska 2007
tomato	lycopene	- 36.60	Hallmann and Rembiałkowska 2007a
tomato	lycopene	-19.21	Hallmann and Rembiałkowska 2008
tomato juices	lycopene	+ 29.34	Hallmann and Rembiałkowska 2008
		- 23.64	
bell pepper	sum of carotenoind	+ 2.98	Rembiałkowska et al. 2005
bell pepper	sum of carotenoind	+ 10.80	Hallmann et al. 2007
bell pepper	sum of carotenoind	+ 7.33	Hallmann and Rembiałkowska 2007
bell pepper	sum of carotenoind	+ 7.89	Hallmann et al 2008
bell pepper	sum of carotenoind	+3,43	Hallmann and Rembiałkowska 2008
		+6.49	



The content of carotenoids in two carrots cv .'Perfekcja' i 'Flacoro' from organic and conventional cultivation in 2010



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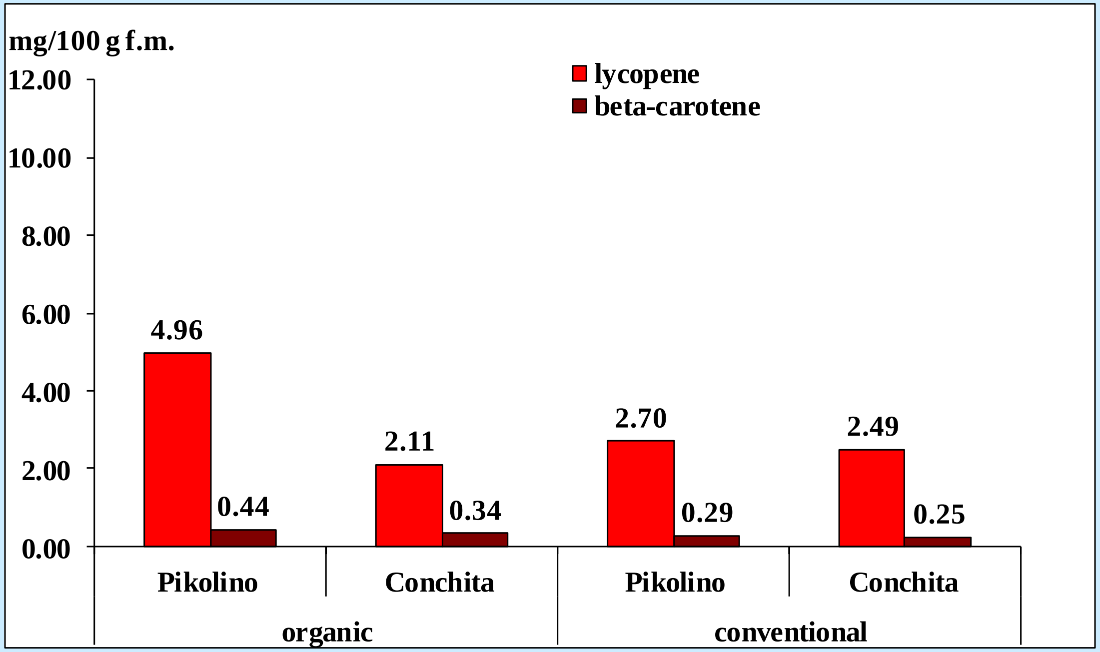
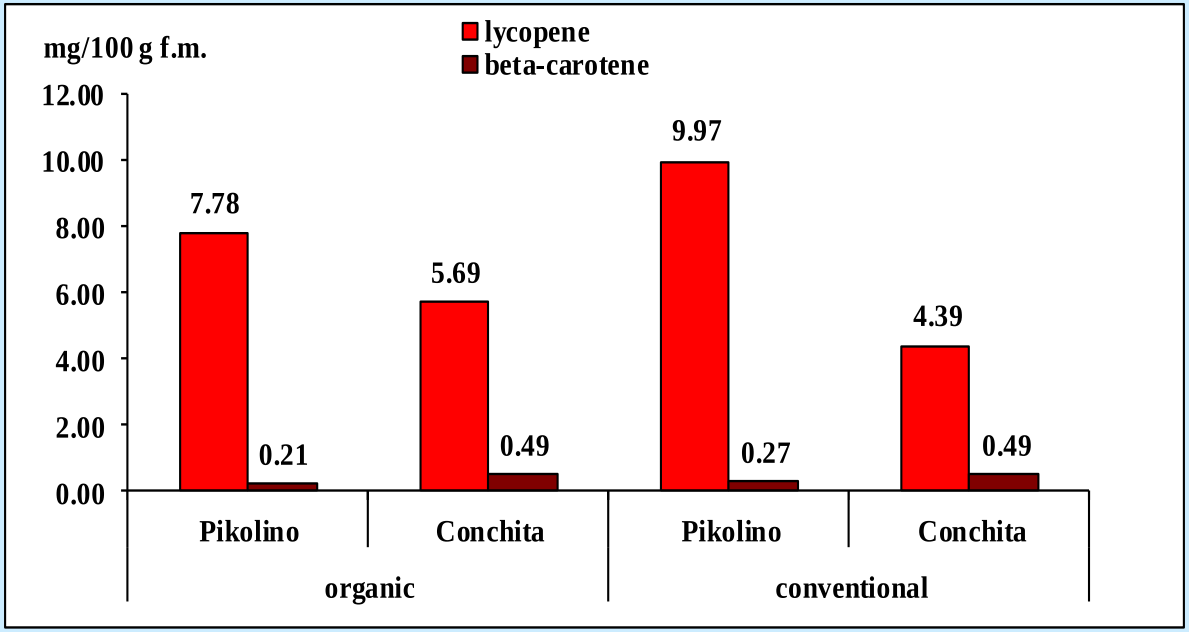
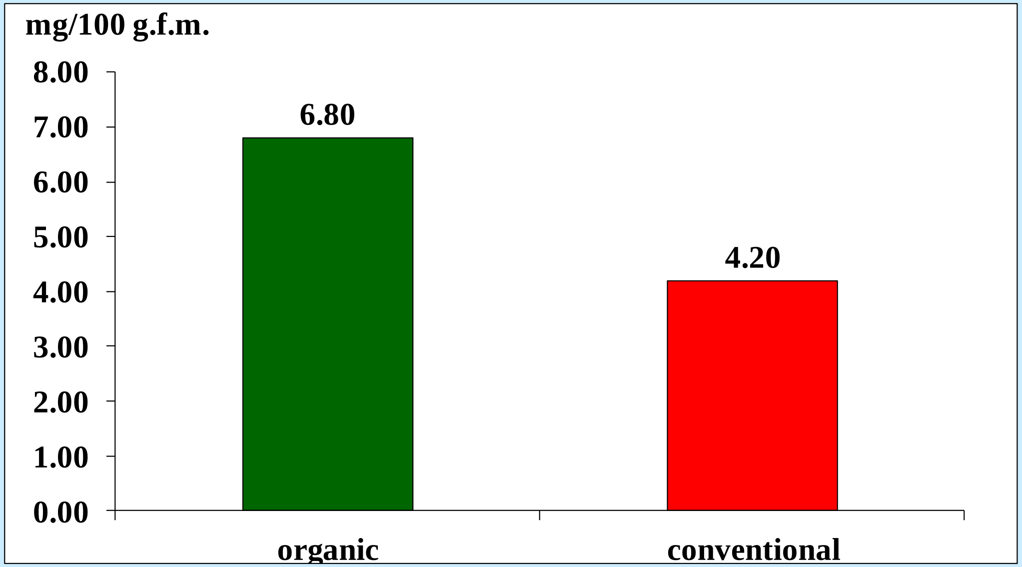


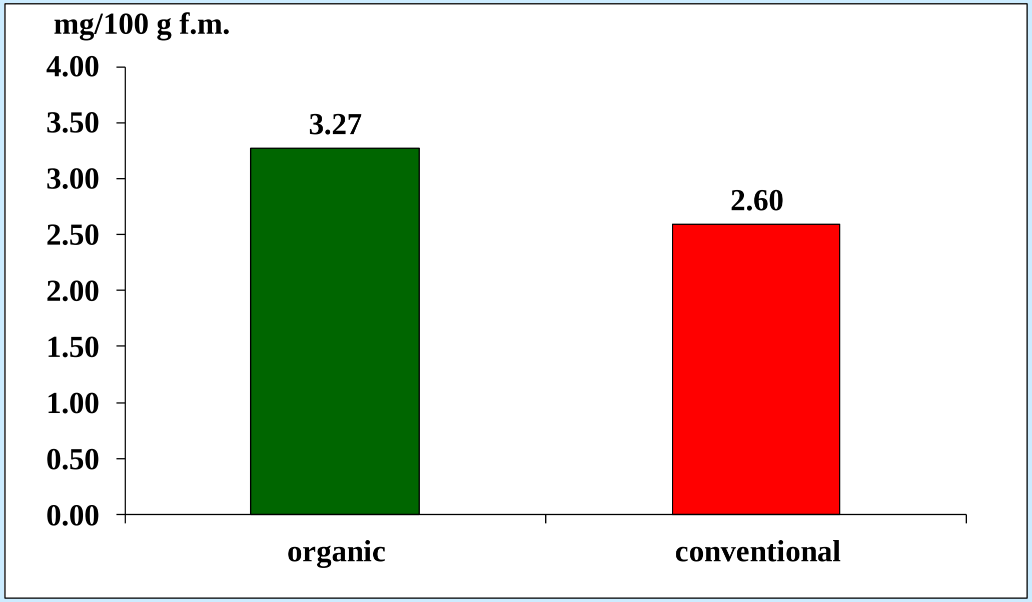
The content of carotenoids in cherry tomato 'Pikolino' i 'Conchita' fruits from organic and conventional cultivation in 2007



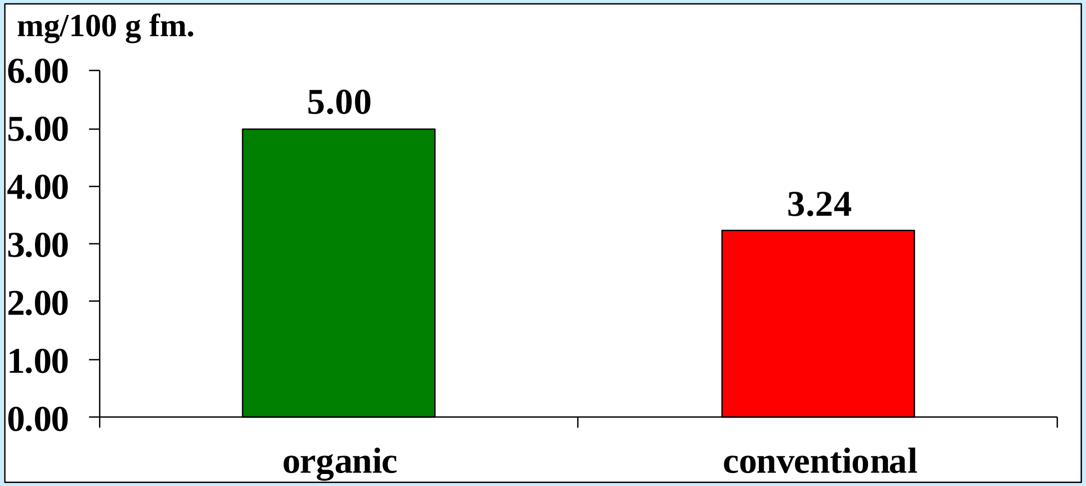
The content of carotenoids in cherry tomato 'Pikolino' i 'Conchita' fruits from organic and conventional cultivation in 2008

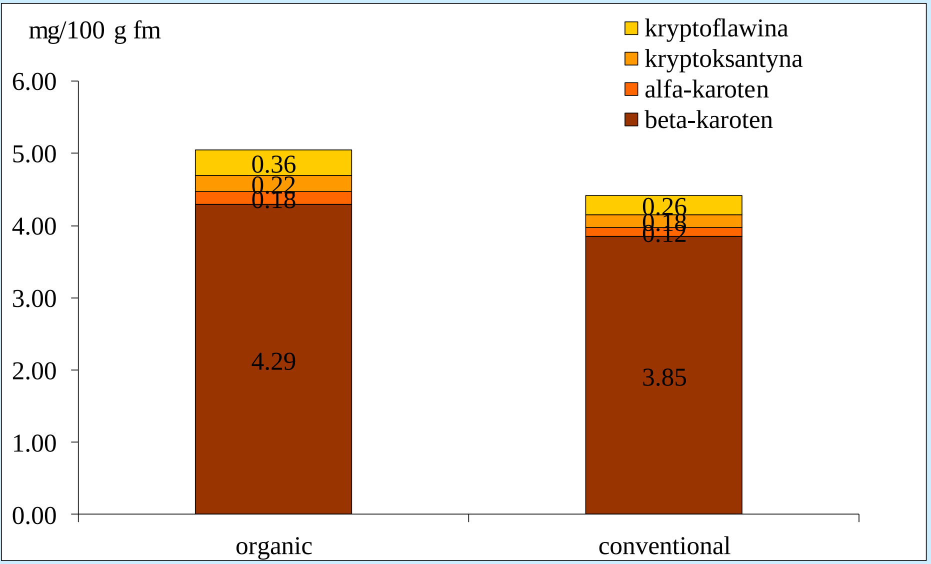


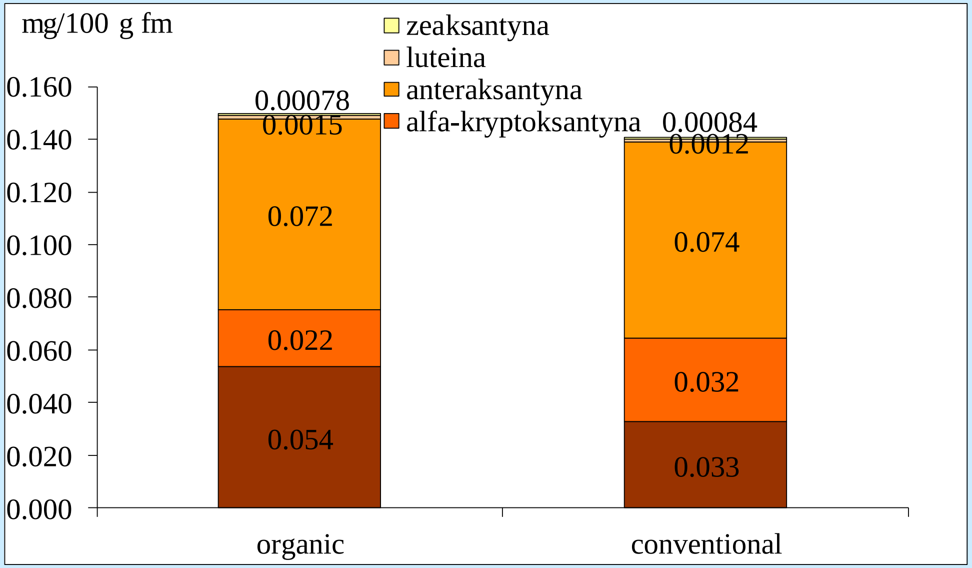
The content of carotenoids in red pepper fruits from organic and conventional cultivation in 2006



The content of carotenoids in red pepper fruits from organic and conventional cultivation in 2007







Carotenoids profile in organic and conventional bell pepper

Vitamin C benefits for human health

1. It is vital to the production of collagen, which is involved in the building and health of skin and blood vessels
2. It may help reduce allergy symptoms (it has natural antihistamine properties)
3. It helps protect the fat-soluble vitamins A and E, low-molecule antioxidants (glutathione), flavonoids as well as fatty acids from oxidation
4. It helps to prevent damage to cells from free radicals (free radical scavengers)
5. It is needed for antibody production
6. It facilitates assimilation of non-hem iron by human organism and takes part in blood cells synthesis
7. It stop synthesis of toxic nitrosamines in human stomach.

Selected bioactive compounds with antioxidative activity (antioxidants)

Vitamn C (ascorbic acid)

Higher consumption of vegetables which are rich in vitamin C was correlated with higher level of ascorbic acid in blood plasma and it could be used as a biomarker of heart attack. 196 500 of volunteers were examined (people from group of risck) In 42% cases the high level of plasma vitamin C was positively corelated with low level of heart attack. (Myint i in. 2008)

5-a-day fruits and vegetables consumption by 170 volunteers with esophagus tumors was positively correlated with decreasing of development cancer cells in comparison to control group (182 people), who eat vegetables only one-a-day (Thompson i in. 2009)

SOURCES OF VITAMIN C

Vegetables:

❖***Solanacae* family:** bell pepper, tomatoes, patatoes

❖***Cruciferae* family:** kale, kolhrabi, broccoli, culiflower, brousels sprout, red cabbage, savoy cabbage, chinensis cabbage, withe cabbage, radish, turnip, rutabaga



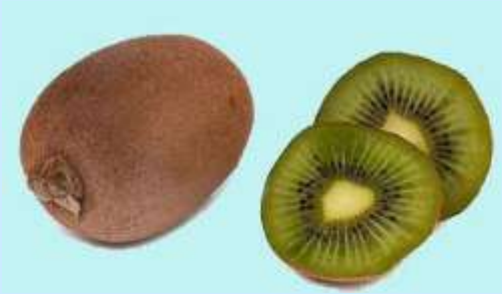
❖ ***Umbelliferae* family:** parsley (root and leaves)

Fruits:

- **berries:** blackcurrant, redcurrant, strawberry, goosberry
- **apples**



- **exotic fruit:** kiwi, tangerine, grapefruit, orange, lemon



Compare of vitmain C content in vegetables, potatoes from organic and conventional production

vegetables	Difference in % org/conv.	source
Spinach	+37.48	Vogtmann i in. 1984
Spinach	+77.59	Schuphan 1974
Celery	+10.96	Leclerc i in. 1991
Celery	+18.64	Schuphan 1974
White cabbage	+75.84	Schuphan 1974
White cabbage	+30.12	Rembiałkowska 1998
Lettuce	+58.76	Schuphan 1974
Leek	+28.52	Lairon i in. 1986
Potatoes	+16.77	Petterson 1978
Potatoes	+16.96	Schuphan 1974
Potatoes	+99.06	Fischer i Richter 1986
Potatoes	+20.91	Rembiałkowska i Rutkowska 1996
	+ 40.92	



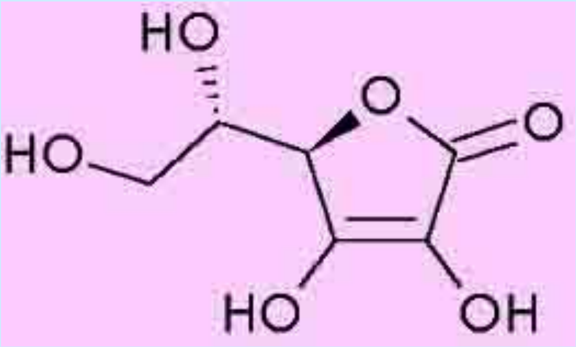


Compare of vitmain C content in fruits and vegetables from organic and conventional production /continue/

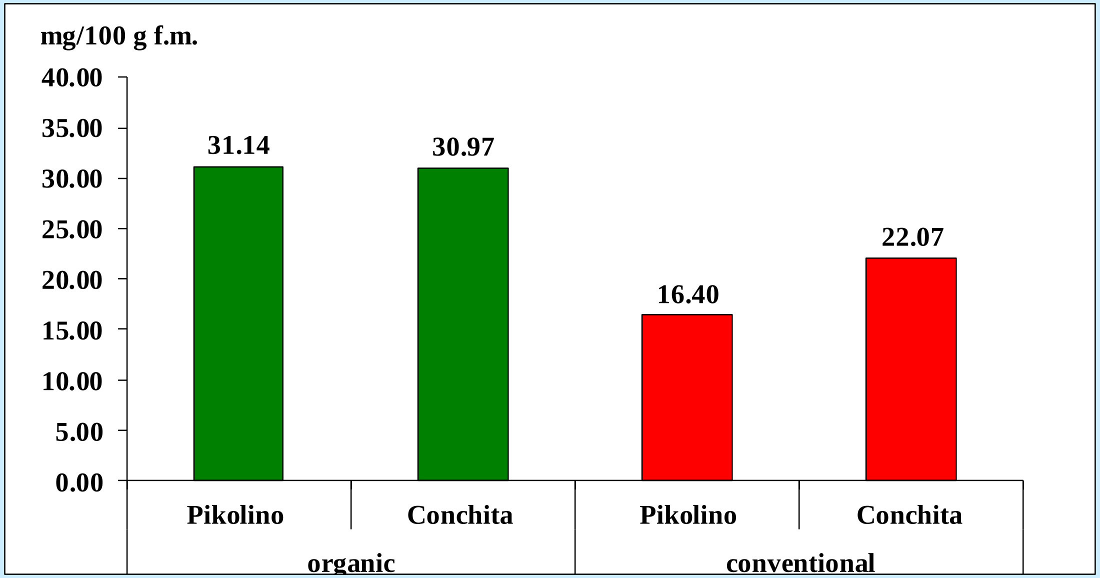
species	(-) less / (+) more org/conv in %	source
	vitamin C	
potatoes	+13.3	Kolbe et al. 1995
potatoes	+8.05	Hajslova i in. 2005
cabbage	+11.0	Warman et al. 1997
corn	-34.38	Asami i in. 2003
young beet greens	+10.61	Moreira i in. 2003
red pepper	+23.3	Pérez-López et al. 2007
orange	+11.96	Rapisarda i in. 2005
	+20.55	

❁ Organic vegetables contained more vitamin C
Results obtained in Division of Organic Food (WULS)

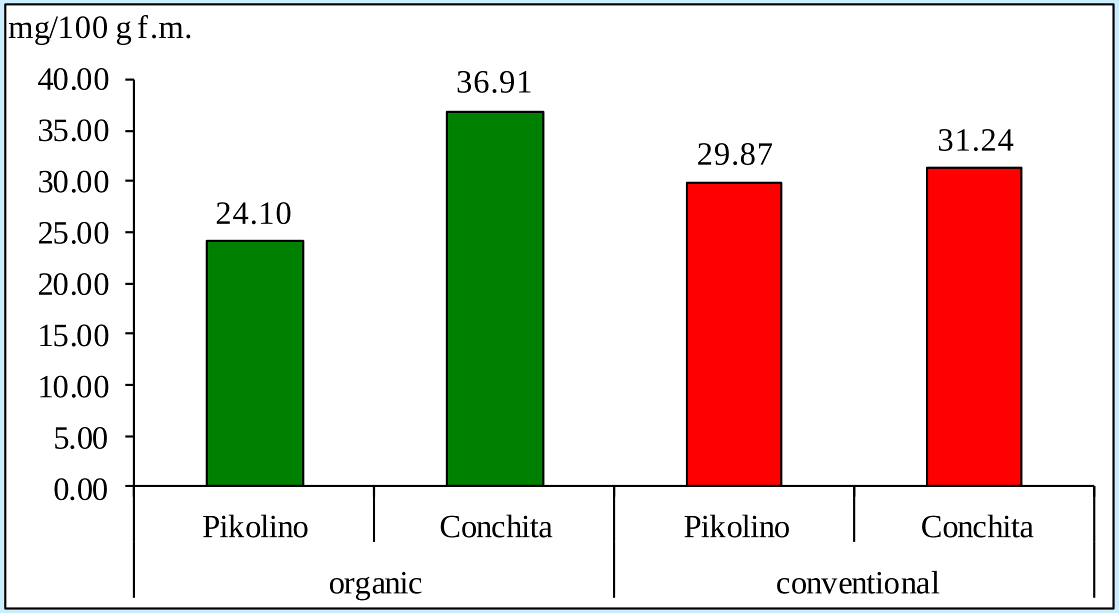
species	(-) less / (+) more org/conv in %	source
	vitamin C	
onion	+129.90	Hallmann i Rembiałkowska 2006
potatoes	+ 21.0	Rembiałkowska 2000
tomatoes	+18,7	Hallmann and Rembiałkowska 2007
tomatoes	+49.0	Hallmann and Rembiałkowska 2007a
tomatoes	-30.93	Rembiałkowska i in. 2003 b
tomatoes	+41.51	Hallmann, 2005
tomatoes	+35.04	Rembiałkowska, 2005
tomatoes (cherry)	+28.0	Rembiałkowska et al. 2005
red pepper	+26.79	Hallmann, 2005
red pepper	+13.37	Hallmann i in. 2007
red pepper	+20.1	Rembiałkowska et al. 2005
apples	+32.91	Rembiałkowska i in. 2003 a
	+32.12	



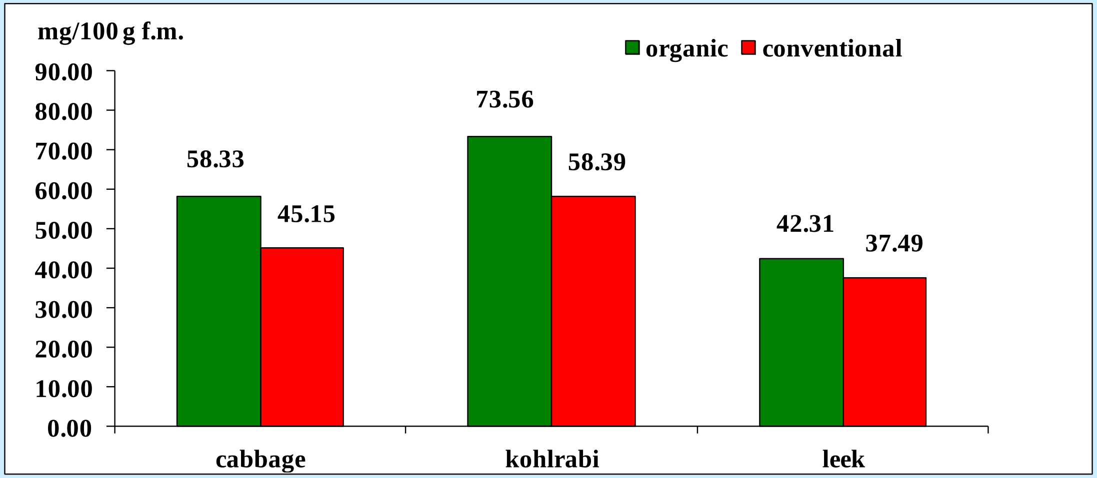
vitamin C



The content of vitamin C in cherry tomato ‘Pikolino’ i ‘Conchita’ fruits from organic and conventional cultivation in 2007

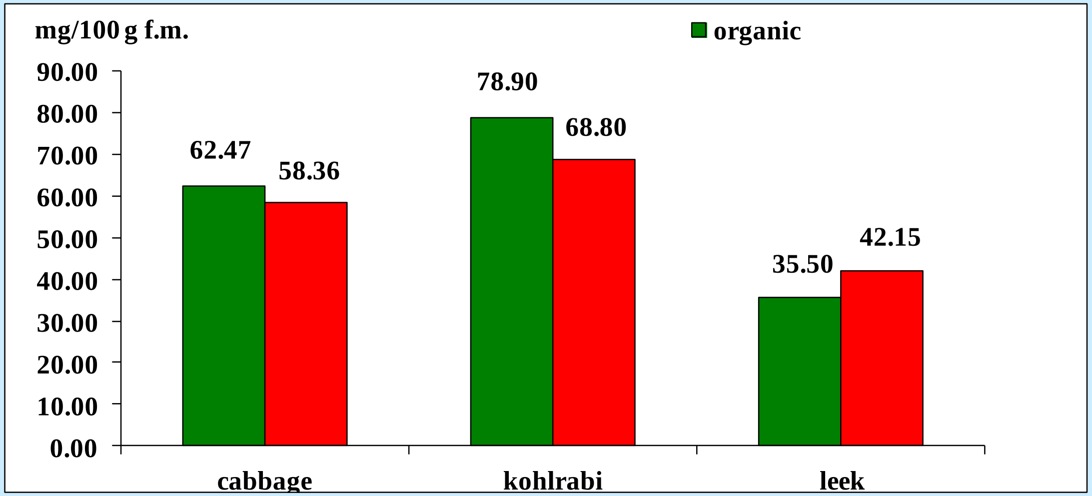


The content of vitamin C in cherry tomato ‘Pikolino’ i ‘Conchita’ fruits from organic and conventional cultivation in 2008



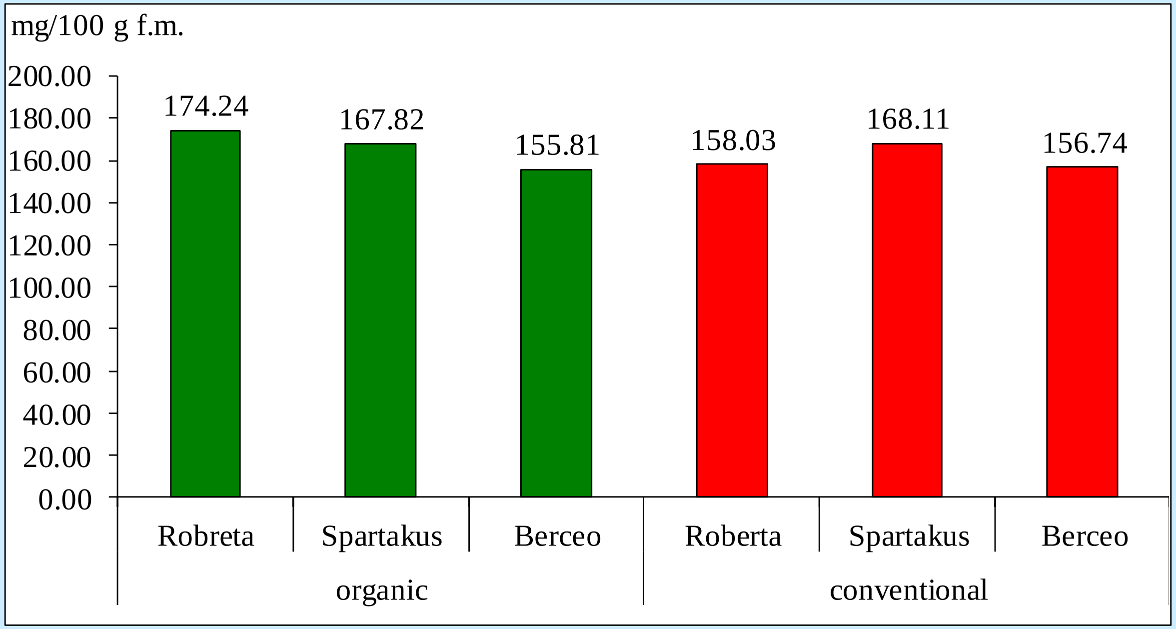
The content of vitamin C in organic and conventional cabbage, kohlrabi and leek

2006



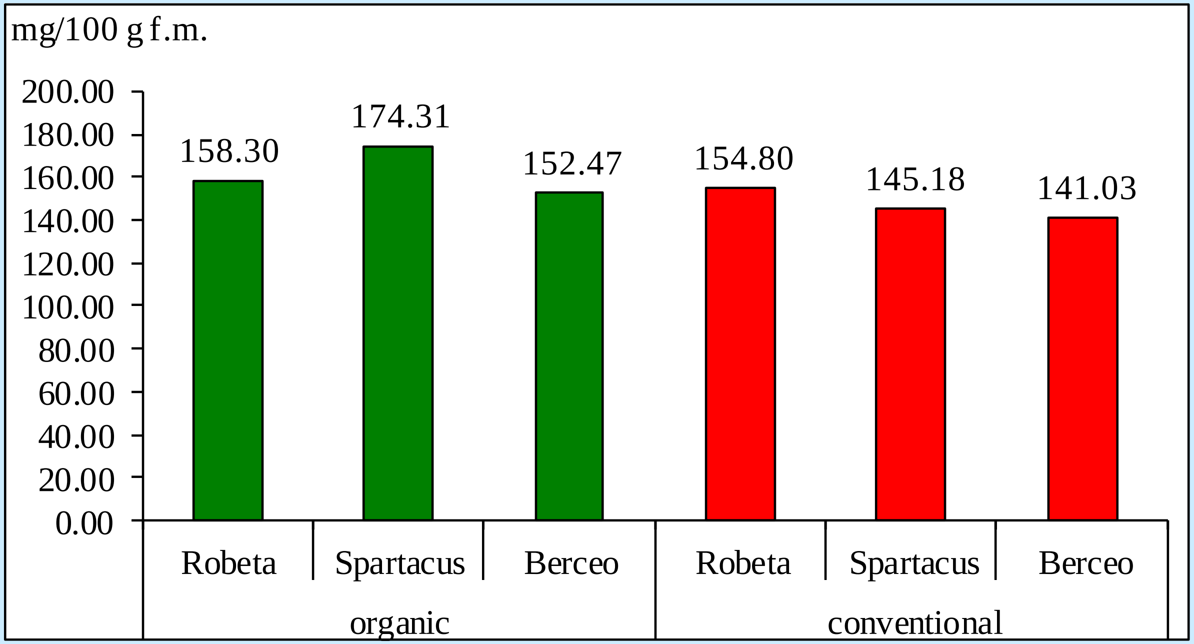
The content of vitamin C in organic and conventional cabbage, kohlrabi and leek

2007



The content of vitamin C in organic and conventional red pepper

2007



The content of vitamin C in organic and conventional red pepper

2008

Nominal division of plants metabolite’s compounds:

1. phenolic comounds

phenolic acids (chlorogenic, caffeic, cinnamonic)

flavonoids:

flavons (apigenin, hesperidin, luteolin)

flavanons (naringenin, taxipholin)

flavonols (quercetin, kaempferol, myrcytin, rutin)

flavanols (catechin, epicatechin, epigalocatechin)

isoflavonols (daidzein, genistein)

anthocyanins (cyjanidin, malwinidin, pelargonidin, petunin)

2. Terpenoids

monoterpenoids (limonen, mentol)

tetraterpenoids (carotenoids, xantophyll)

3. Nitrogen compounds (alcaloids, amines, amino acids non-proteins, glycosides, glucosinolates)

Flavonoids benefits for human health

1. They enhance arteries wall and protect against bloods micro-effusion.

2. They protect vitamin C against oxidation. There is experimental evidence that certain flavonoids have anti-inflammatory properties, and there are reports that orally administered flavonoids may have antiviral and antimicrobial activities.

3. May affect the relaxation capabilities of blood vessels and reduce risk of stroke.

4. They are leading to decreases in LDL-cholesterol oxidation and plaque formation on arterial walls. This can reduce heart attack risk.

5. Soya-beans bioflavonoids are recommended for woman in post-menopause age.

Penolic compounds

Phenolic acids (polyphenol acids)

Regular daily consumption 2 cups of coffee or 4 cups of black tea was positively correlated with diminishing of diabetes symptoms (II type non-insulin depends). The examined group of suffer volunteers was 37,000 people. That effect cause the regular consumption of chlorogenic and caffeic acids from infusions (Odegaard et al. 2008)


Regular consumption of berry fruits, especially strawberry influence on decreasing of LDL cholesterol and increasing of HDL cholesterol among examined group of volunteers (72 people) with diagnosis of potential risk of coronary attack, but not change the total cholesterol level also triacyloglicerol level (Erlund i in. 2008)


1. **Phenolic compounds: Flavonoids**

Flavons (apigenin, vitexin, hesperydidin, luteolin,)
(leaves and fruits of hawthorn, bitter orange, peppermint leaves)

Apigenin is one of bioactive flavons which can activate a very specifically **protein p53**. This protein is all the time present in cells, but in sleep mode (not active). It function is protection cell's DNA against mutations and cancerogenesis. Because developing tumors blocking protein p53 carcinogenesis process is start. When apigenin is inject to cells, the blocking of p53 is remove and carcinogens agents making apoptosis and cells back to normal faze (Liu 2005).

Vitexin can stop a very specifically monophagus proteins in case of cardiac inflammation. It can slow down illness development Kowalski et al. (2006).

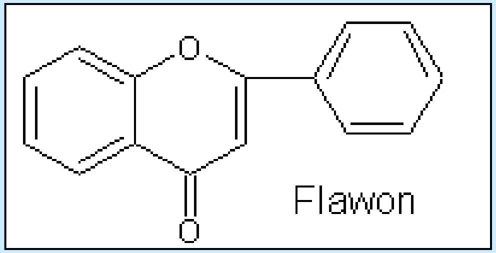
Hesperidin can be use to treat phlebitis insufficiency (Garg i in. 2001) and can reduce cholesterol and triacetyloglicerols level in blood (Monforte i in. 1995)

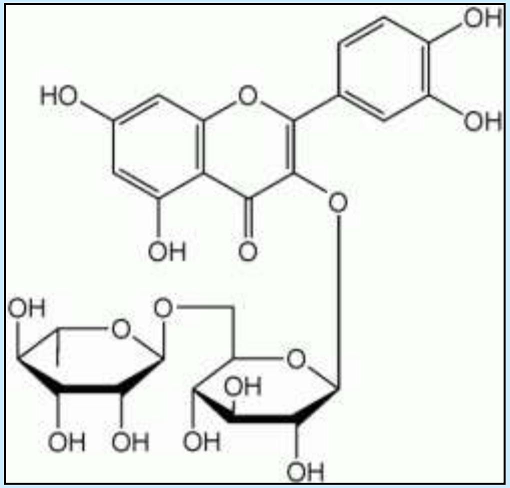

Regular consumption of vegetables rich in luteolin (broccoli, kale) was positively correlated with decreasing esophagus tumor (Sesso i in. 2003)


Flavanones (naringenin, taxipholin)
(grapefruit, oranges, peach)

Regular consumption during two month 750 ml (per day) orange juice influence positively HDL cholesterol synthesis about 21% and decreased LDL-HDL ratio about 16% (Kurowska et al. 2010).

Injection of taxipholin to cells of mouse delayed formation of breast tumors (Ebeler et al 2012)





•**flavonoles (kaempferol, quercitin, rutin, myrcytin)**

(black and green tea, leaves and fruits of sloe (*Prunus spinosa*), brasicaceae and solanaceae family vegetables)

Vegetables rich in kaempferol consumption diminish risk of pancreatic cancer in huge group of volunteers (183,500 men), who drink two cup of tea per day and eat twice per day solanaceae vegetables (Nöthlings et al 2008).

Drinking two or three cup per day of black tea did not change incidence of breast and womb cancer in group of 3234 elder woman (Wang et al. 2009)

flavanoles (catechin, epicatechin, epigallocatechin)

Catechins from black tea, cocoa drink and vegetables significantly diminished risk of ischaemic heart disease in group of volunteers (806 man in 65-85 age) (Hollman i in. 2001)



Epigallocatechin from green tea not significantly influenced to keeping of low body mass after losing weight treatment in group of 5634 woman (Hursel i in. 2009)


SOURCES OF FLAVONOIDS

- **citrus fruit:** grapefruit, orange, tangerine,

- **fruit:** berries: strowberry, raspberry, goosberry, blackberry, bilberry apples, plums,

- **vegetables :** bell pepper, cherry tomatoes, broccoli, onion, garlic, letuce,

Polyphenols content in fruit preserve from organic and conventional production methods

- Higher total phenolic content in organic juice of Bordo variety in comparison to conventional one

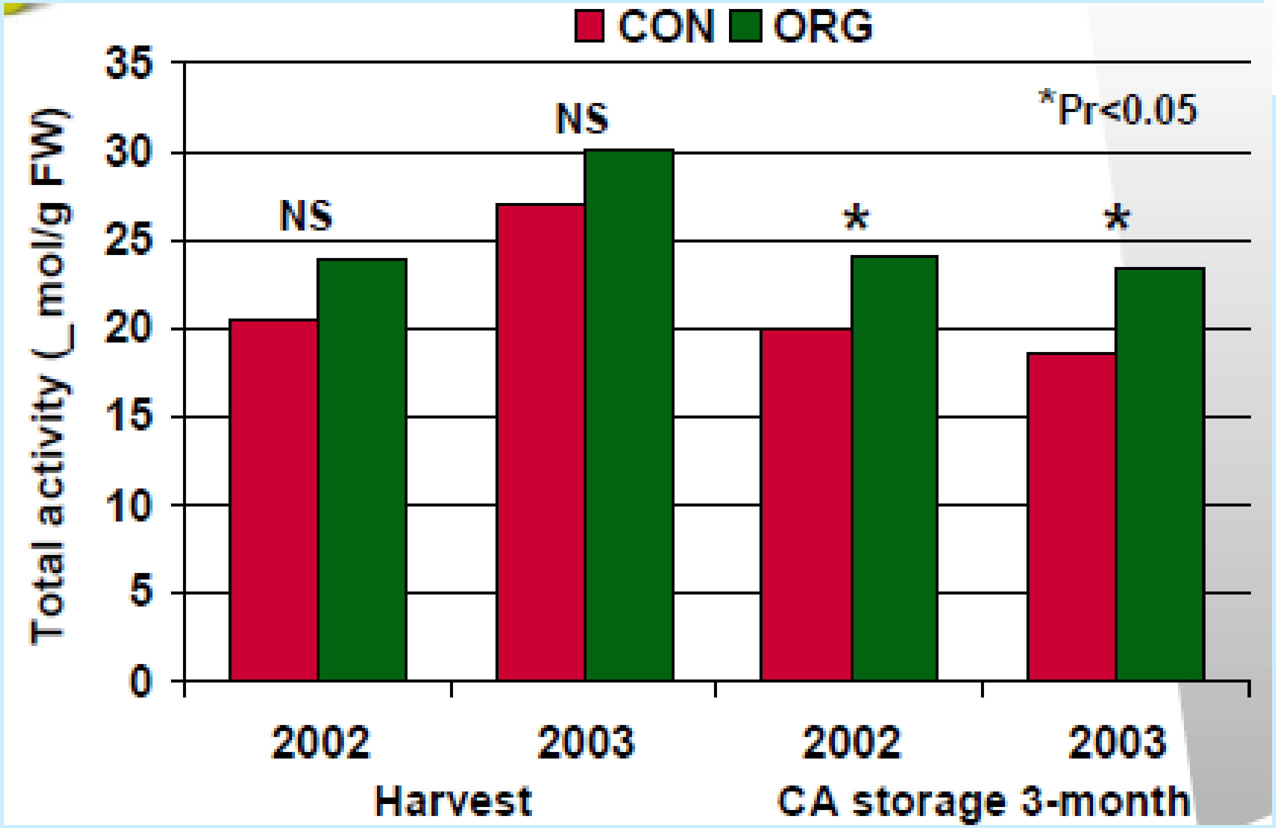
- The organic Bordo grape juice presented a higher level of trans-resveratrol, quercitin, rutin, gallic acid, caffeic acid and total flavonoids than conventional one

Machado et al. 2011

Quality of organic and conventional apples and strawberries - comparative studies (according to Reganold et al., 2001, *Nature*; Peck et al., 2006 *HortScience*; Kramer et al., 2006, *PNAS USA*)

Apple

(antioxidant activity)



Compare of polyphenols content in fruits from organic and conventional production

Literature review

Plants	Bioactive substance	Content		Difference in % org/conv.	Source
		ORG	CONV		
Apples	Polyphenols (mg / 100g d.m.)	4.66	3.93	+18.58	Weibel et al. 2000
Peach	Polyphenols (mg /100 g f. m.)	26.7	19.6	+36.22	Carbonaro and Mattera 2001
Peach	Polyphenols (mg of tannic acid/100g f.m.)	29	21.3	+36.15	Carbonaro et al. 2002
Pear	Polyphenols (mg /100 g f. m.)	49.5	48.2	+2.70	Carbonaro and Mattera 2001
Pear	Polyphenols (mg of tannic acid/100g f.m.)	64.5	58.4	+10.45	Carbonaro et. al. 2002
Marrionberries	Polyphenols (mg /100 g f.m.)	600	400	+50.00	Asami et al. 2003
Strawberries (frozen)	Polyphenols (mg /100 g f.m.)	280	240	+16.67	Asami et al. 2003
Strawberries	Quercetin (mg/100g f.m.)	0.722	0.69	+4.64	Anttonen et al. 2006
Strawberries	Kampherol (mg/100g f. m.)	0.692	0.784	-11.73	Anttonen et al. 2006
				+ 18.19	





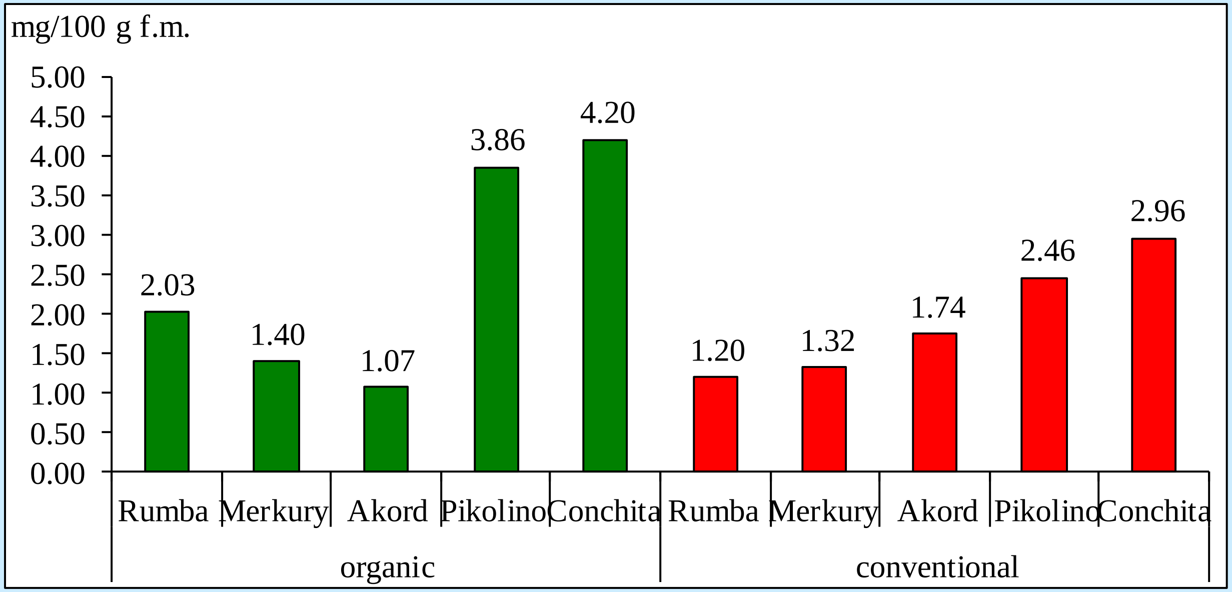
Compare of polypchenols content in fruits and vegetables from organic and conventional production /continue/

Plants	Bioactive substance	Content		Difference in % org/conv.	Source
		ORG	CONV		
Chinese cabbage Pac Choi	Polyphenols (mg of quercetin/g d.m.)	13.5	12.5	+8.00	Young et al. 2005
Corn (frozen)	Polyphenols (mg /100 g f.m.)	40	25	+60.00	Asami et al. 2003
Lettuce	Polyphenols (mg of quercetin/g d.m.)	15.2	11.5	+32.17	Young et al. 2005
Apples	Flavonoles (mg of quercetin/100g f.m.	1.34	0.73	+83.56	Rembiałkowska et al. 2003
Apples	Flavonoids (mg/100g d.m.)	2.75	2.37	+16.03	Weibel et al. 2004
				+39.95	

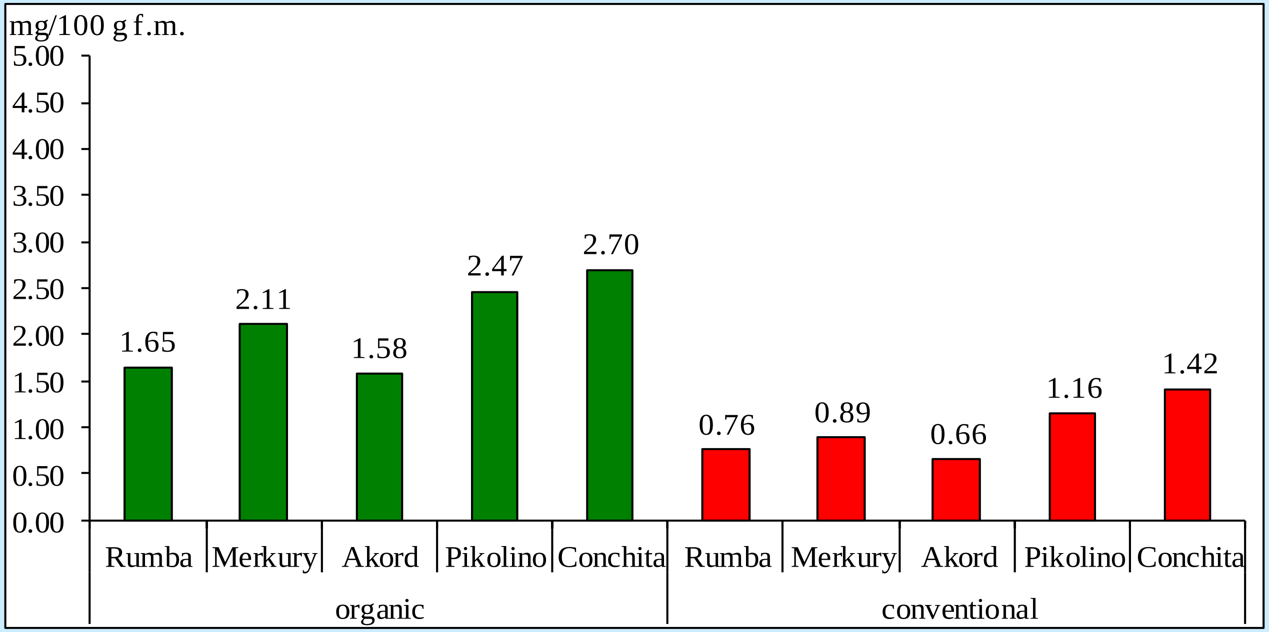



Organic fruits, preserve and vegetables contained more polyphenols Results obtained in Division of Organic Food (WULS)

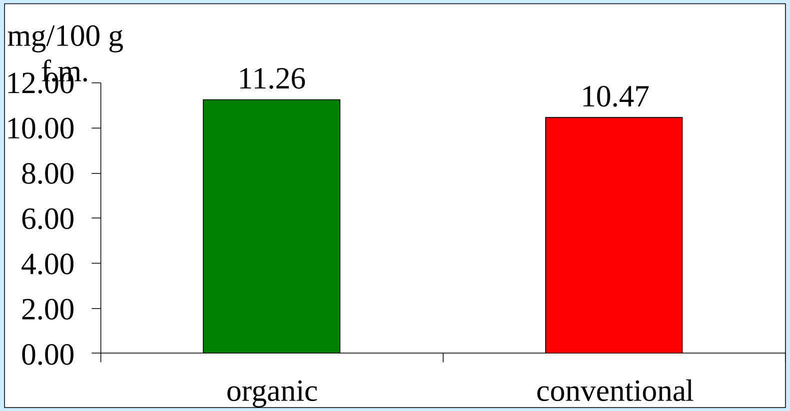
Plants	Bioactive substance	Bioactive substance content		Difference in % org/conv.	Source
		ORG	CONV		
Red pepper	Flavonoles (mg/100 g f.m.)	33.81	14	+141.46	Hallmann et al. 2005
Onion	Flavonoles (mg quercetin/100 g f.m.)	95.27	84.61	+12.60	Hallmann and Rembiałkowska 2006
Onion	Anthocyans (g/100 g f. m.. mg% delphinidin)	14.61	8.37	+74.55	Hallmann and Rembiałkowska 2006
Tomatoes	Flavonoles (mg of quercetin/100 g f.m.)	0.83	0.48	+72.92	Rembiałkowska et al. 2003
Apple juice	Polyphenols (mg/l)	397.3	304.6	+30.43	Rembiałkowska et al. 2006
Apple mousse	Polyphenols (mg/100 g d.m.)	712.4	604.6	+17.83	Rembiałkowska et al. 2006
				+58.30	



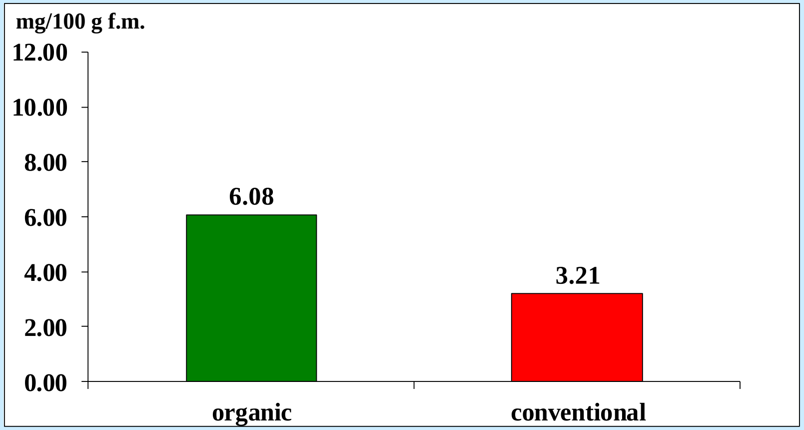
The content of flavonols in tomato fruits from organic and conventional cultivation in 2007



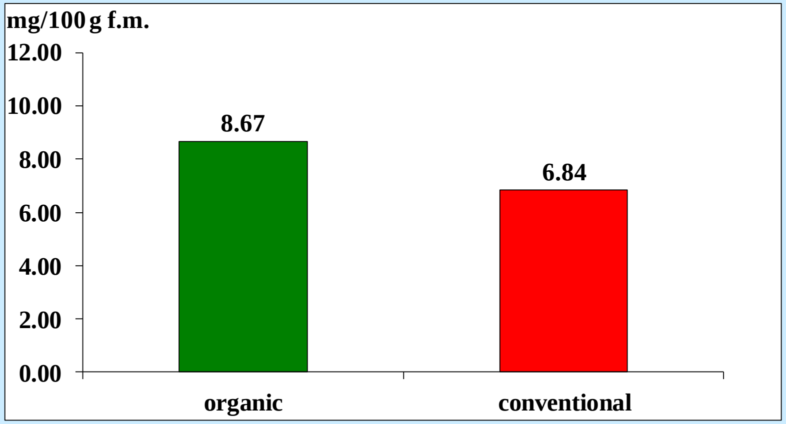
The content of flavonols in tomato fruits from organic and conventional cultivation in 2008



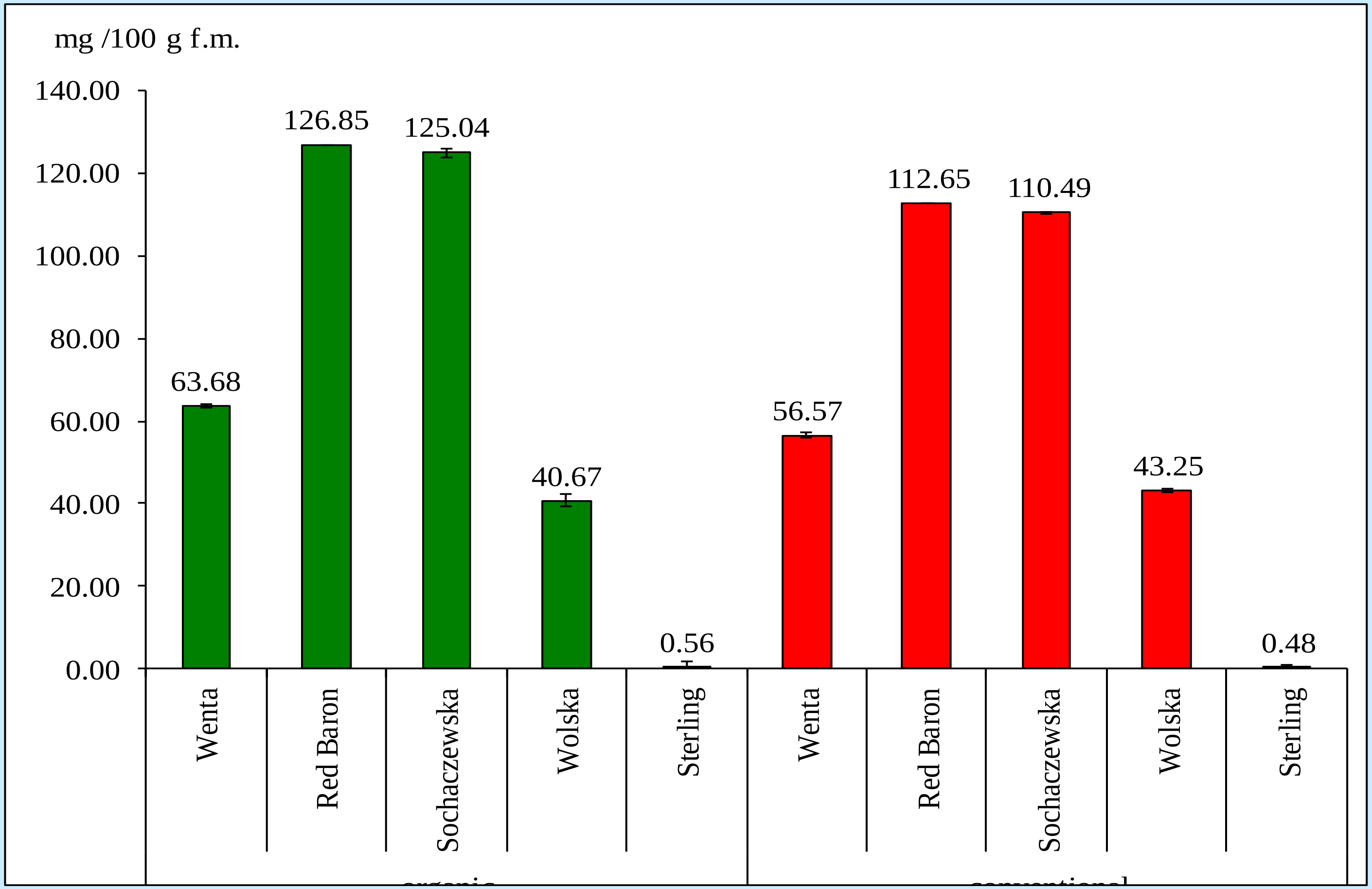
The content of flavonols in red pepper fruits from organic and conventional cultivation in 2006

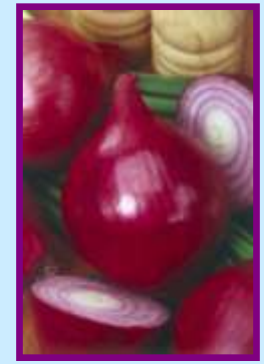


The content of flavonols in red pepper fruits from organic and conventional cultivation in 2007

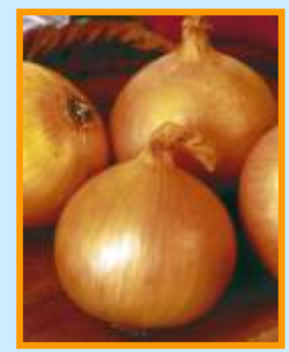


The average content of flavonols in red pepper fruits from organic and conventional cultivation in 2006-2007





The content of flavonols in onion bulbs from organic and conventional cultivation in 2006



ANTHOCYANINS

Antocyanins are pigments responsible for the red, purple, and blue colors of many fruit, vegetables, seeds and flowers.

They are often observed in the plant kingdom, where it serves to color anything from fruit to the autumn leaves. The pigment acts as a powerful antioxidant helping to protect the plant from UV damage.

Today, interest in anthocyanin pigments has intensified because of their possible health benefits as dietary antioxidants. Over 300 structurally distinct anthocyanins have been identified in nature. Anthocyanins are one class of flavonoid compounds, which are widely distributed plant polyphenols.

Anthocyanins benefits for human health

- may also improve eyesight by several mechanisms e.o. helping eyes for their ability to adapt to light and dark.

- may increase the production of stomach mucus and protect the stomach from injury.

- they prevent blood clotting and relax blood vessels.

- may have antioxidant abilities and are being studied for their anticancer potential and defend cells against dangerous carcinogens.

- they have been found to inhibit some human tumor cells

Forget-Me-Not

• The Forget-Me-Not has been used as a symbol of remembrance for those who have suffered or have been lost in war. In Newfoundland, Canada, Forget-Me-Not flowers are worn on July 1 each year in memory of those who died in World War I.

• The Forget-Me-Not is a symbol of Alaska, as it is the state flower. The Forget-Me-Not flower has also been adopted as a symbol for Canada's Alzheimer Society; Alzheimer's disease is the progressive mental deterioration of the brain, hence the Forget-Me-Not symbol of memory loss.

Cornflowers

•In folklore, cornflowers were worn by young men in love; if the flower faded too quickly, it was taken as a sign that the man's love was unrequited.

•The cornflower is also the symbol for Motor Neurone Disease and Amyotrophic Lateral Sclerosis

SOURCES OF ANTHOCYANINS:

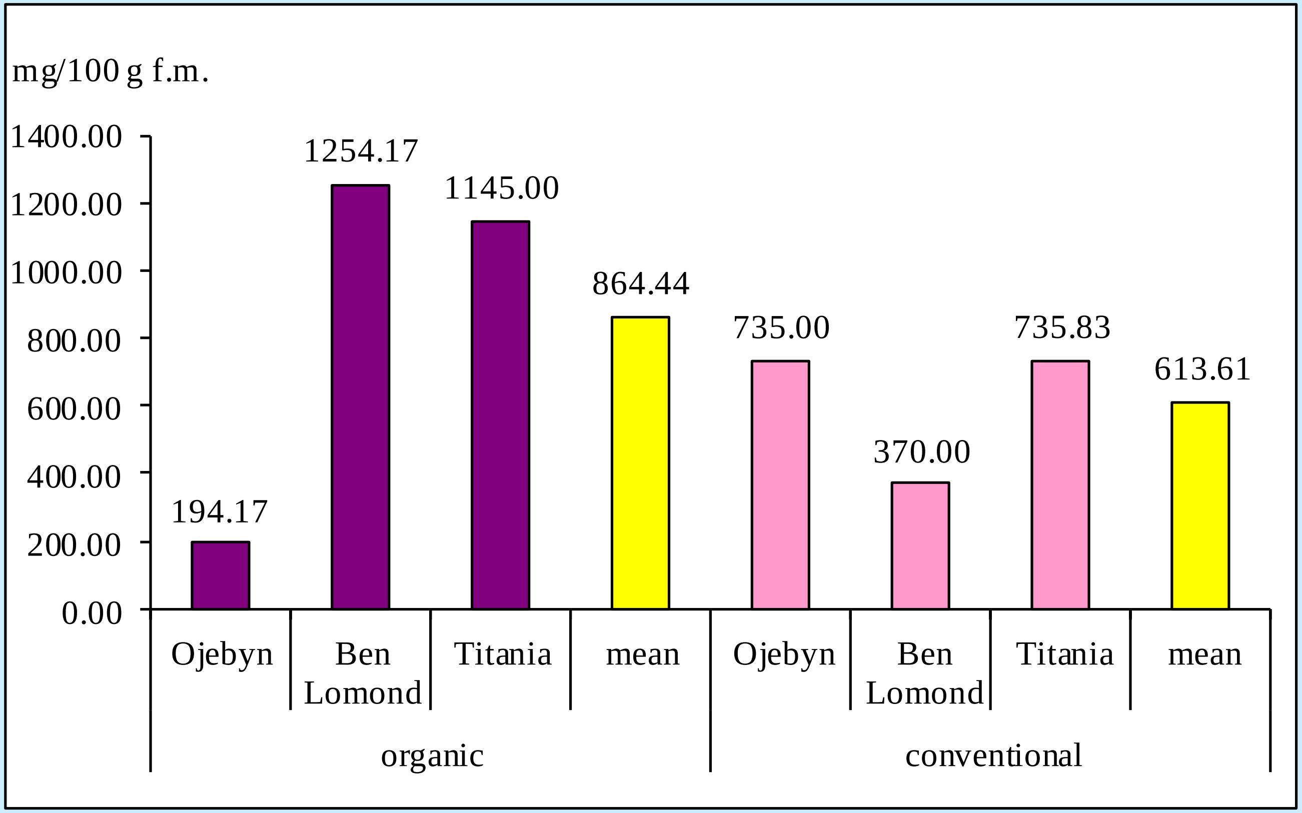
❖ **Fruit:** blackcurant, apples, plums, bilbery, blackberry, grapes, aronia



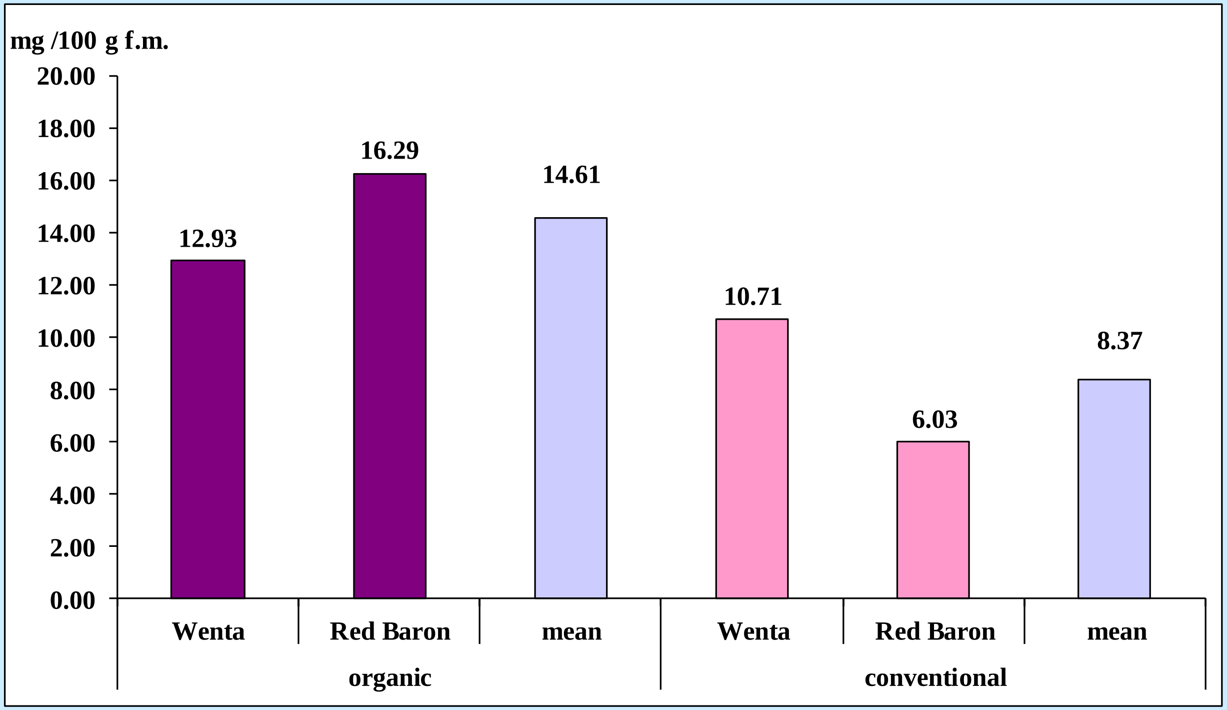

❖**Vegetables:** aubergine, letuce, broccoli and kale with purple leaves, red onion, purple pepper, red cabbage, ridacchio







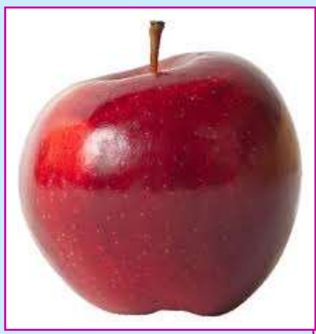
The content of antocyanins in organic and conventional black currant

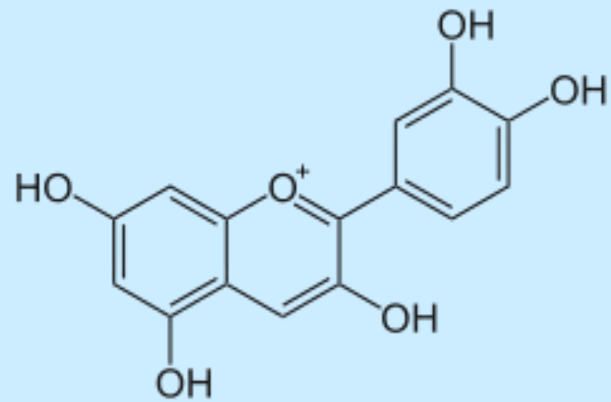


The content of antocyanins in organic and conventional onion bulbs

❁ Organic fruits contained also more anthocyanins:

species	Difference in % org/conv.	source
	anthocyanins	
strawberry	+ 0.66	Wang et al. 2003
apples (integ/conv.)	+ 22.52	Veberic et al. 2005
blood orange	+ 16.40	Tarozzi et al. 2006
	+13.19	

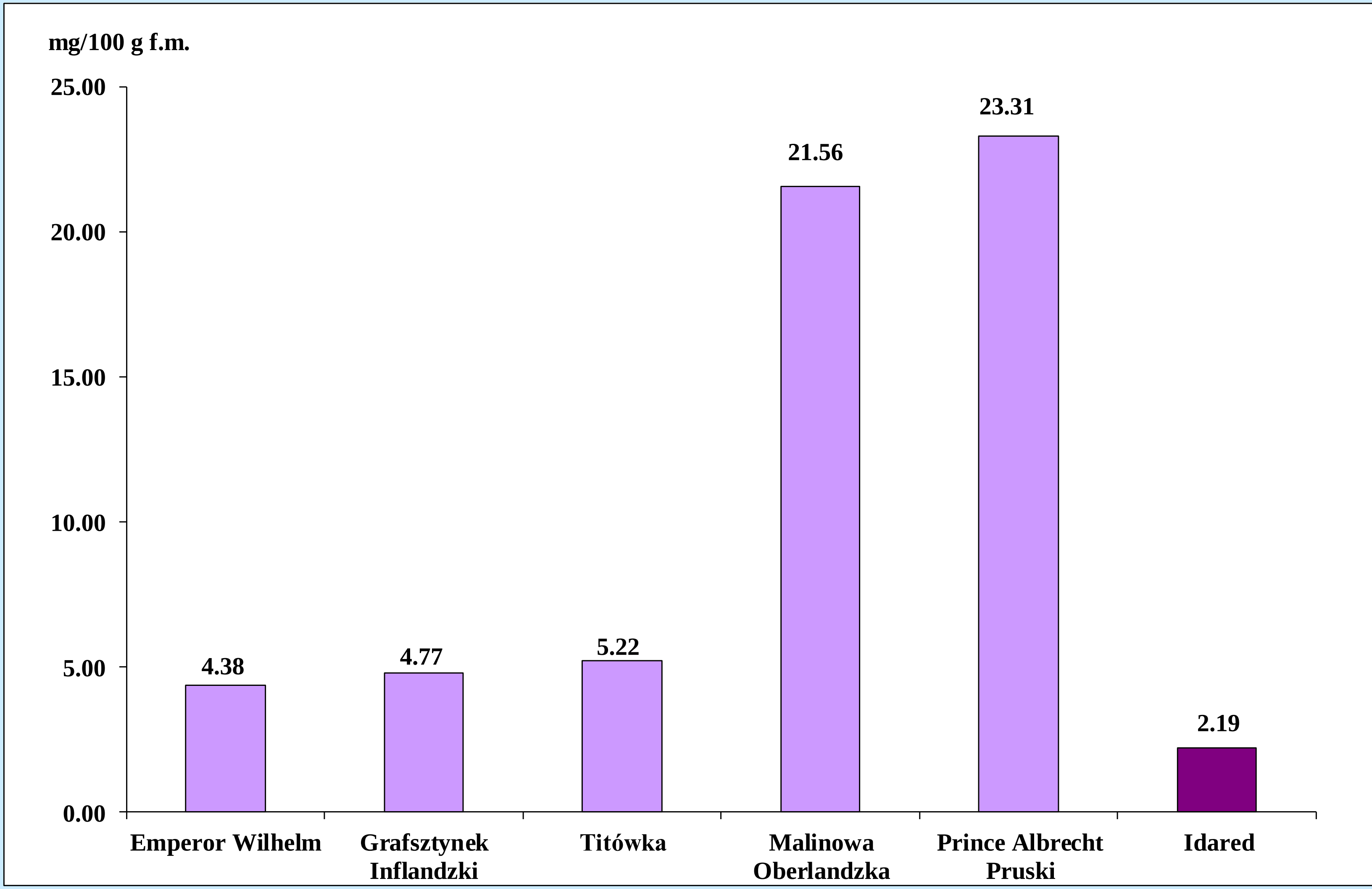




cyanidin

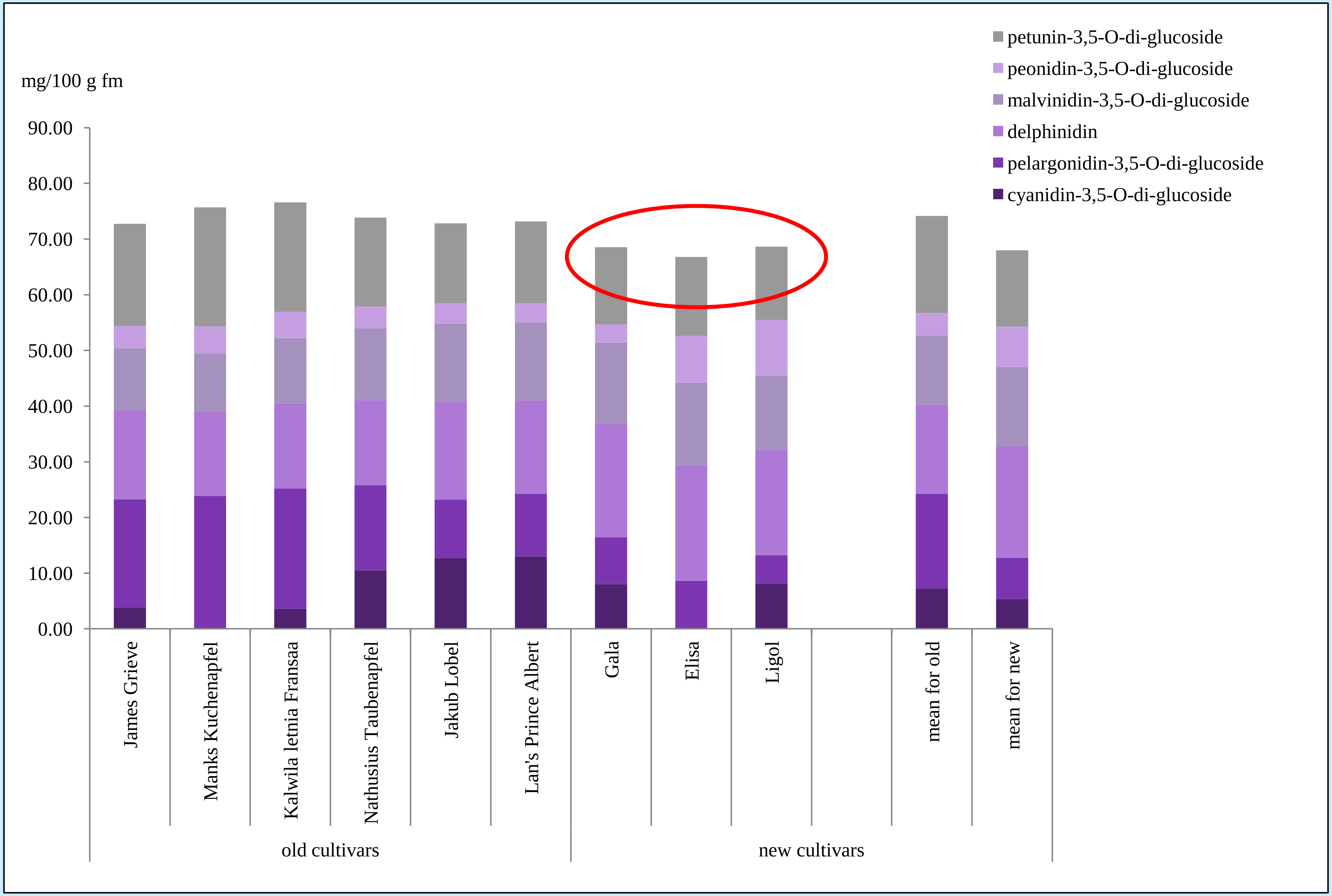
Organic vegetables contained more antocyanins
Results obtained in Division of Organic Food (WULS)

species	Difference in % org/conv.	source
	anthocyanins	
apples	+317.73	Rembiałkowska et al. 2003
apples	+69.75	Rembiałkowska et al. 2004
onion	+74.53	Hallmann i Rembialkowska 2007
	+154.00	

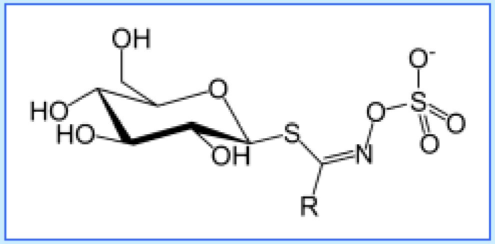



The content of antocyanins in the old and the new apples cultivars

The profile of antocyanins in the new and the old apple cultivars



Glucosinolates



The glucosinolates are a class of organic compounds that contain sulfur and nitrogen and are derived from glucose and an amino acid. They occur as secondary metabolites of almost all plants of the order Brassicaceae

Plants use substances derived from glucosinolates as **natural pesticides** and as defense against herbivores; these substances are also responsible for the bitter or sharp taste of many common foods such as mustard, radish, horseradish, cabbage, brussels sprouts, kohlrabi, kale, cauliflower, broccoli, turnip, rutabanga

alifatic glucosinolates:

glukoiberin
progoitrin
sinigrin
Glukorafanin
glukobrassicanapin
sulphoraphan
alliloizotiocyanane
phenyloizothiocyaniane

Indol’s glucosinolates:
4-hydroksyglukobrassycin
glukobrassycin
4-metoksyglukobrassycin
neoglukobrassycin
indol-3-karbinol

✓Isothyocianate and indole products formed from glucosinolates may regulate cancer cell development by regulating target enzymes, controlling apoptosis and blocking the cell cycle

✓Nevertheless, variation in content of both glucosinolates and their bioactive hydrolysis products depends on both genetics and the environment, including crop management practices, harvest and storage, processing and meal preparation

✓After physical damage to the plant tissue, glucosinolates are broken down, by the endogenous enzyme myrosinase, releasing glucose and a complex variety of biologically active products. The most important and extensively studied of these compounds are the **isothiocyanates.**

Summary of antimutagenic results

vegetable	mutagen added	% reductiuon
culiflower	nitrate+methylurea	78
culiflower	nitrate+aminopiryne	57
cabbage	nitrate+sorbic acid	Moderate (not calculable)
culiflower	nitrate+sorbic acid	Moderate (not calculable)
cabbage	tryptophan pyrolysate	97
broccoli	tryptophan pyrolysate-1	97
broccoli	tryptophan pyrolysate-2	81
broccoli	ethidium bromide	92
broccoli	2-Aminoanthracene	84
broccoli	AF-2	0
broccoli	Oxidized linolenic acid	82
cabbage	Oxidized linolenic acid	76
red cabbage	Oxidized linolenic acid	81
culiflower	Oxidized linolenic acid	76
cabbage	Tryptophan pyrolysate-2	35

CONCLUSIONS:

1. **Organic fruit and vegetables contained more vitamin C, flavonoids, anthocyanins (generally bioactive substances) than conventional produce and this confirms C/N balance theory.**

2. **Though conventional vegetables (bell pepper and tomatoes) contained more lycopene in comparison to organic ones, the rest of carotenoids were more abundant in organic vegetables.**

3. **Organic fruit and vegetables can be recommended as health – supporting plant products useful in cancer prevention.**

Thank you for attention