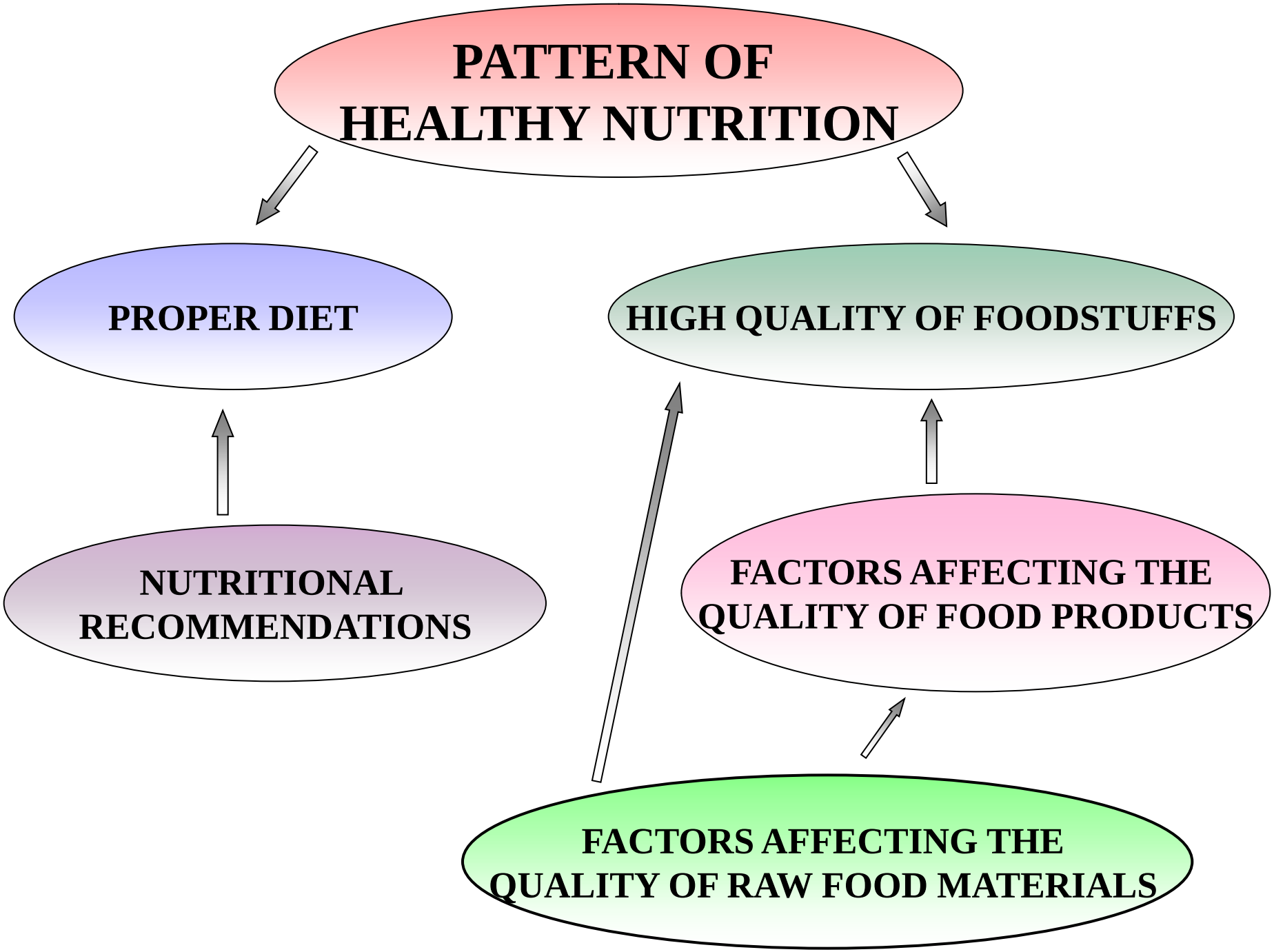
FOOD QUALITY, NUTRITION AND HEALTH

dr hab. Ewelina Hallmann

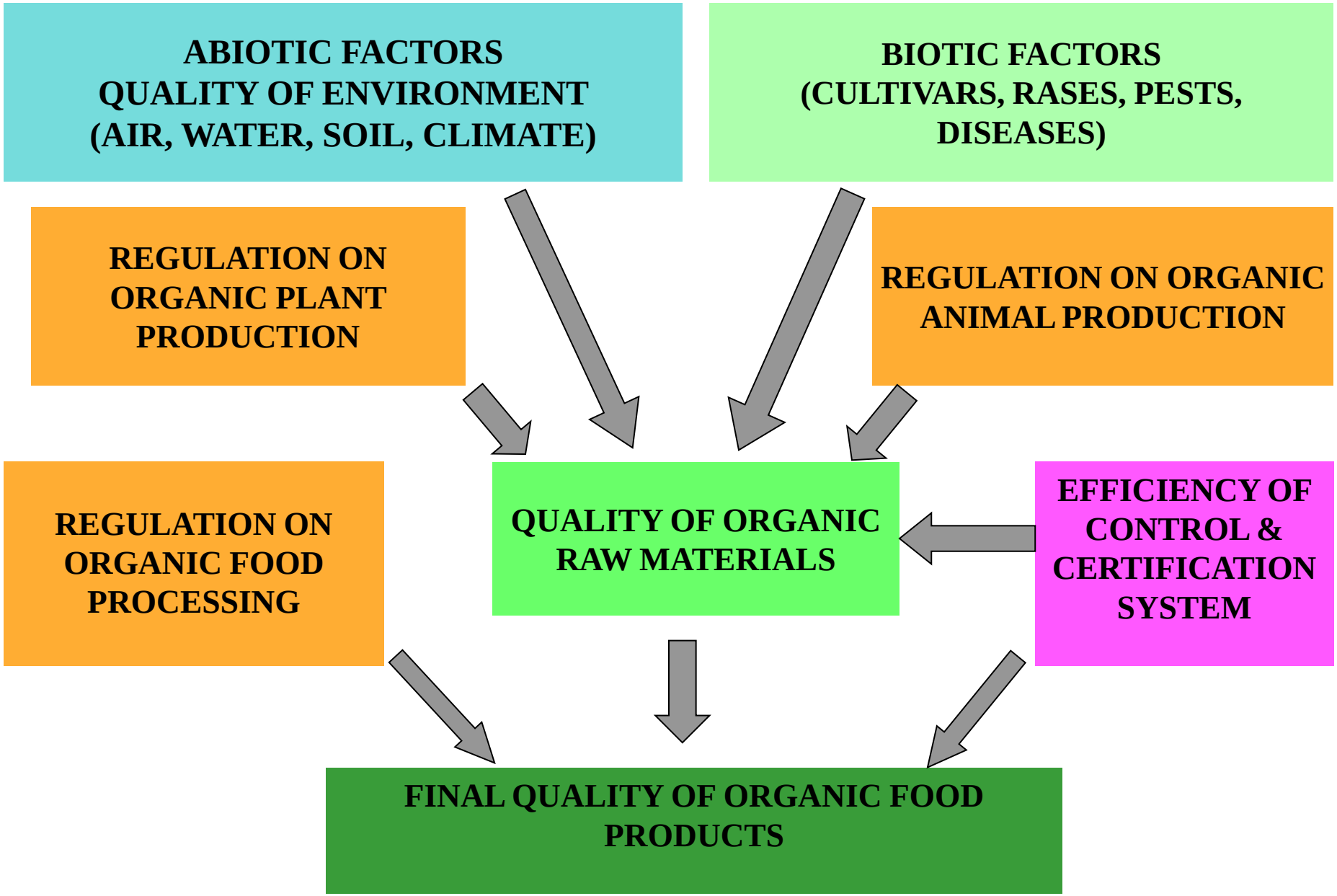
Division of Organic Food


PATTERN OF HEALTHY NUTRITION
PROPER DIET
HIGH QUALITY OF FOODSTUFFS
NUTRITIONAL RECOMMENDATIONS
FACTORS AFFECTING THE QUALITY OF FOOD PRODUCTS
FACTORS AFFECTING THE QUALITY OF RAW FOOD MATERIALS

Nutritional recommendations elaborated by the specialists from FAO / WHO and Polish Nutritional Institute:

- health safety in a diversity of the consumed foodstuffs
- supporting of proper body mass protects from the metabolic diseases
- dark bread richer in vitamins, mineral compounds and fiber than white bread and rolls
- two glasses of skimmed milk daily secure sufficient quantity of calcium
- fish is better source of proteins than meat
- a lot of vegetables and fruits secure sufficient quantity of vitamin C, β-carotene, mineral compounds and fibre to our organism
- limited consumption of animal fats is a necessary condition of arteriosclerosis prevention
- avoidance of sweets protects our teeth from caries (decay) and facilitates to support the proper body mass
- less salt - smaller risk of hypertension and probably also cancer
- indulging too freely in alcohol ruins our health - moderation is recommended!

FACTORS INFLUENCING THE QUALITY OF ORGANIC FOOD PRODUCTS

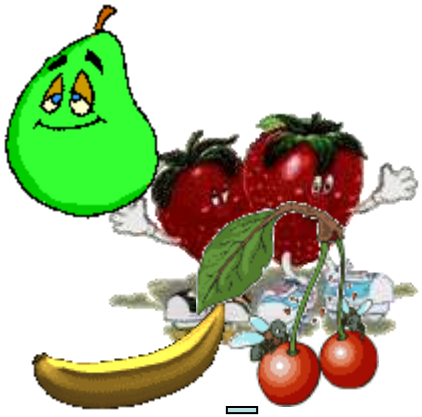


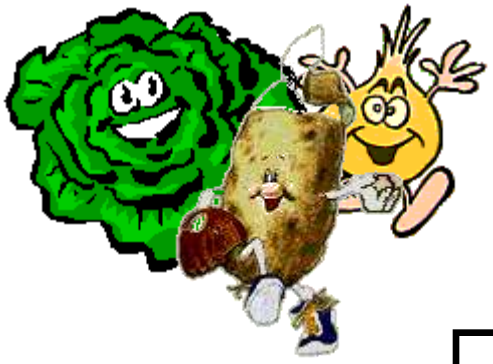
Food contamination, sources and negative human health effect

Food contamination	Sources	Negative health effect
Heavy metals		
Cadmium (Cd)	Industry (non-ferrus matallurgy) Agriculture (phosphoric fertilizers)	Damage od kidneys and liveer, osseous system , prostate cancer
Lead (Pb)	Industry Pots for food, cands Transport (lead petrol)	Disturbances of protein synthesis, anemia, neurological and cerebral changes
Mercury (Hg)	Chemical, electrochemical and dyeing industry Agriculture (pesticides, seed dressing?)	Paralysis of nervous system Mutagenic and tetratogenic impact
Arsenic (As)	Metal forming industry Petroleum rafinery Agriculture (pesticides)	Carcinogenic impact Metabolic diseases
Nitrates, nitrites	Agriculture (nitric mineral fertilizers), Food processing	Methemoglobinemia
Nitrosoamines	Agriculture (nitric mineral fertilizers), Food processing	Carcinogenic impact
Pesticides Seed dreassing	Agriculture (insecticides, fungicides ect.	Chronic intoxication, damage of nervous and digestive system cencerogenic

Food contamination, sources and negative human health effect

Food contamination	Sources	Negative health effect
Mycotoxins	Agriculture – soil degradation	toxic Carcinogenicity
Chlorinated biphenyls (PCB)	Plastic pacages, greases, paints Insecticides	Toxic activity on whole ORGANISM
Aromatic hydrocarbons(WWA) np. benzo (a) pyren	Processing (grain dried, food smocking_ Communal and industy pollutions, transport	Carcinogenicity
Plant growth stimulators. Choline chloride	Agriculture	Toxic impact on whole organism
Antibiotics, hormones	Animal breeding	Metabolic diturbances, reduction of resistance Asthma, anemia, allergy
Radioactive isotopes	Radiation accidents Trials with nuclear weapon medicine	Leucemia, cancer, radiation sickness
Plastic substances (monomers)	Plastic pacages (polypropylene, polystirene)	Toxic impact





pesticides
Nitrate and nitrites

pesticides
Additives for better taste, odour, consistency
(E-series, benzic acid, sulfides)
mycotoxins

pesticides
antybiotics

pulverizers

pesticides
heavy metals
phosphates

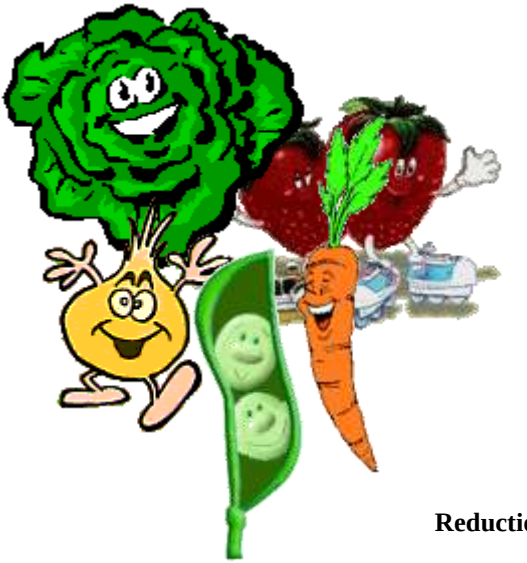
antibiotics
acrylamides

nitrates, nitrites,
detergents

pesticides,
antybiotics,
dioxins

nitrates
sulfonides
detergents

Why excess of nitrates is dengerous for human health?



Fruits and vegetables contain nitrates and nitrites

Reduction of nitrates to nitrites

We eat of fresh fruits and vegetables and ….

Hydrolysis of protein to aminds and aminoacids

…in our stomach react with amines

Synthesis of nitrites and amins

nitrosoamins

(methemoglobinemia) in baby organism
Cancer of digestive trackt (stomach, guts, duodenum)

Fertilization		cultivars				
combination	dose (kg N/ha)	Benita	Hilde	Mona	Neckarriese	Viktoria
Control	0	1110*	660	580	680	860
Green manure	100	1370	1080	780	470	900
Green manure	240	1430	2020	1330	800	1610
NPK	100	5820	5450	5860	4950	6240
NPK	240	16660	14350	12010	12140	12620

mg N/ kg of fresh matter

Maximum levels for nitrates in foodstuffs

(Acc. COMMISSION REGULATION (EC) No 1881/2006

Foodstuffs	Maximum levels (mg NO_3/kg)	
Fresh spinach (*Spinacia oleracea*)	Harvested 1.10 to 31.03	3000
	Harvested 1.04 to 30.09	2500
Preserved, deep frozen or frozen spinach		2000
Fresh lettuce *(Lactuca sativa L.)* (protected and open-grown)	Harvested 1.10 to 31.03: Lettuce grown under cover Lettuce grown in the open air	 4500 4000
	Harvested 1.04 to 30.09: Lettuce grown under cover Lettuce grown in the open air	 3500 2500
Iceberg-type lettuce	Lettuce grown under cover Lettuce grown in the open air	2500 2000
Processed cereal-based foods and baby foods for infants and young children		200

Nitrates content in organic (ORG) and conventional (CONV) vegetables

Plants	Nitrate content (mg/kg)		Difference in the content of bioactive compound in favour of the conventional product*	Difference in the content of bioactive compound in favour of the conventional product**	Author
	ORG	CONV			
Beetroot	1871	2690	+43,77	+35,91	Kunachowicz et al. 1993
Leek	370	499	+34,86	+29,69	Kunachowicz et. al. 1993
Parsley	234	383	+63,68	+48,30	Leszczyńska 1996
Carrot	154	293	+90,26	+62,19	Leszczyńska 1996
Potatoes	145	203	+40,00	+33,33	Leszczyńska 1996
Beetroot	932	2255	+141,95	+83,02	Leszczyńska 1996
Cabbage	147	928	+531,29	+145,30	Leszczyńska 1996
Carrot	52,2	209,7	+301,72	+120,27	Rembiałkowska 1998
Head cabbage	344,3	907,8	+163,67	+90,01	Rembiałkowska 1998
Cabbage	99	512	+417,17	+135,19	Rutkowska 1999
Red cabbage	176	643	+265,34	+114,04	Rutkowska 1999
Carrot	102	461	+351,96	+127,53	Rutkowska 1999
Parsley	116	381	+228,45	+106,64	Rutkowska 1999

Nitrates content in organic (ORG) and conventional (CONV) vegetables

Plants	Nitrates content (mg/kg)		Difference in the content of bioactive compound in favour of the conventional product*	Difference in the content of bioactive compound in favour of the conventional product**	Author
	ORG	CONV			
Potatoes	99	229	+131,31	+79,27	Rembiałkowska 2000
Carrot	155	266	+71,61	+52,73	Rembiałkowska 2000
Cabbage	344	908	+163,95	+90,10	Rembiałkowska 2000
Beetroot	1343	2217	+65,08	+49,10	Rembiałkowska 2000
Potatoes	167,8	201,1	+19,85	+18,05	Wawrzyniak et al. 2004
Celery	488,8	656,9	+34,39	+29,34	Wawrzyniak et al.. 2004
Bok choy (Chinese leaves)	552,1	1045,7	+89,40	+61,78	Wawrzyniak et al. 2004

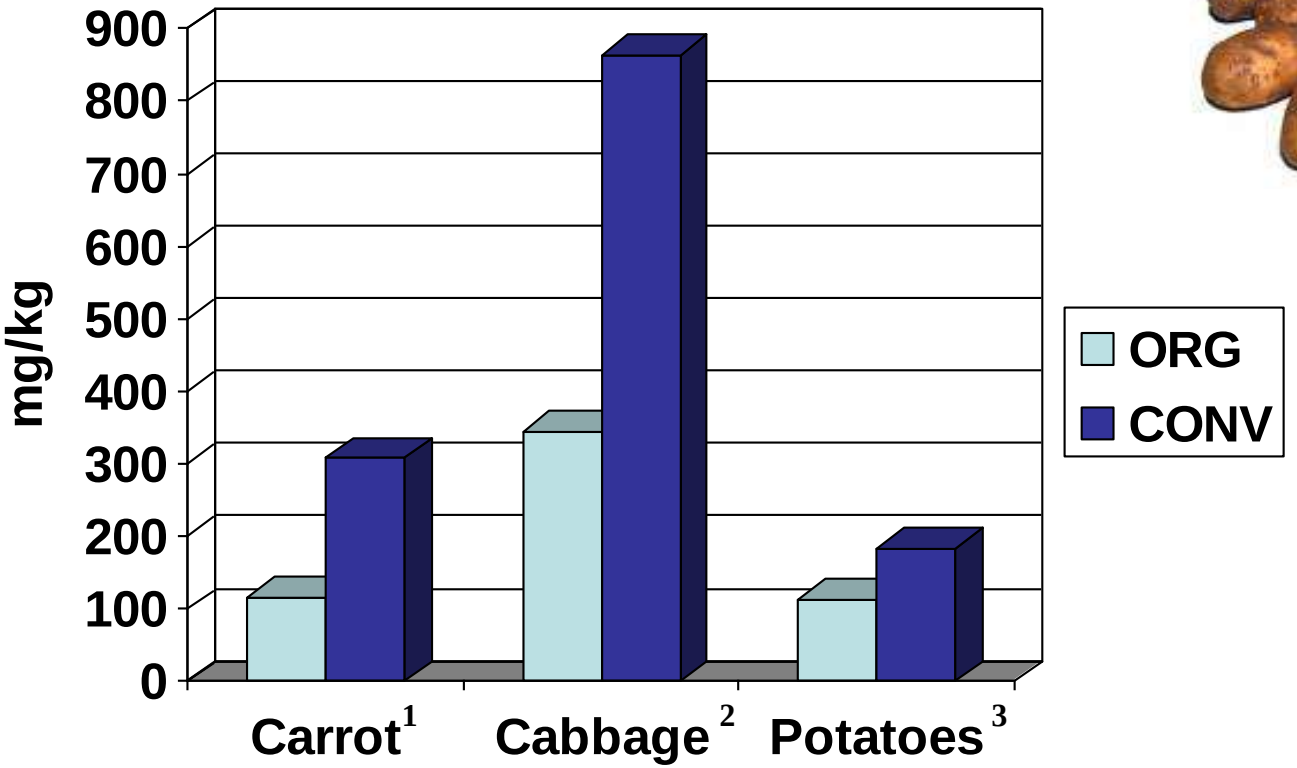
Nitrates content in organic (ORG) and conventional (CONV) vegetables

Plants	Nitrates content (mg/kg)		Difference in the content of bioactive compound in favour of the conventional product*	Difference in the content of bioactive compound in favour of the conventional product**	Author
	ORG	CONV			
Head cabbage	788,7	1061,6	+34,60	+29,50	Wawrzyniak et al. 2004
Potatoes	132	210,3	+59,32	+45,75	Hajslova et al. 2005
Spinach (frozen)	659	1011	+53,41	+42,16	CVUA Stuttgart 2005
Lettuce	818	1303	+59,29	+45,73	Guadagnin et al. 2005
Arugula	4073	5377	+32,02	+27,60	Guadagnin et al. 2005
Potatoes	15,5	72,8	+369,68	+129,78	Cachoeira Stertz et al. 2005
Mean:			**+ 148,39%**	**+70,47%**	

*Caltulated according to Worthington's system (2001): **(CONV-ORG)/ORG x 100%**

Calculated according to Lockeretz's system: **(CONV-ORG)/[(ORG+CONV)/2] x 100%

Nitrates content in organic (ORG) and conventional (CONV) vegetables



[1]Leszczynska 1996, Rembialkowska 1998, Rutkowska 1999, Rembialkowska 2000;
[2]Leszczynska 1996, Rembialkowska 1998, Rutkowska 1999, Rembialkowska 2000, Wawrzyniak et al. 2004
[3]Leszczynska 1996, Wawrzyniak et al. 2004, Hajslova et al. 2005, Cachoeira Stertz et al. 2005

Pesticides cause at least four serious problems:

- **Acute and heavy poisoning of people; there are every year 26 millions such accidents in the world, and about 200 000 people die**
- **Chronic poisoning of people leading to serious problems – various soft tissue cancers, physiological disturbances, malformations, prenatal damages of children, nervous and psychological changes**
- **Disturbances of biological balance in agro-ecosystems and surrounding ecosystems, lower plant resistance to diseases**
- **Decreased content of nutrients in crops, e.g. some pesticides diminishes the content of carotene in carrots by 15 - 20% and content of vitamin C by 20 - 30%, some of it also decrease vitamin C content in cabbage, maize, spinach and beans**

Complex Mixtures

- The average person's body carries a mixture of several hundred synthetic chemicals
- None of these could have been there before recent times - they are completely novel
- We have no way of characterising the toxicology of this mixture
- The highest dose is received early in life - the most vulnerable period for damage

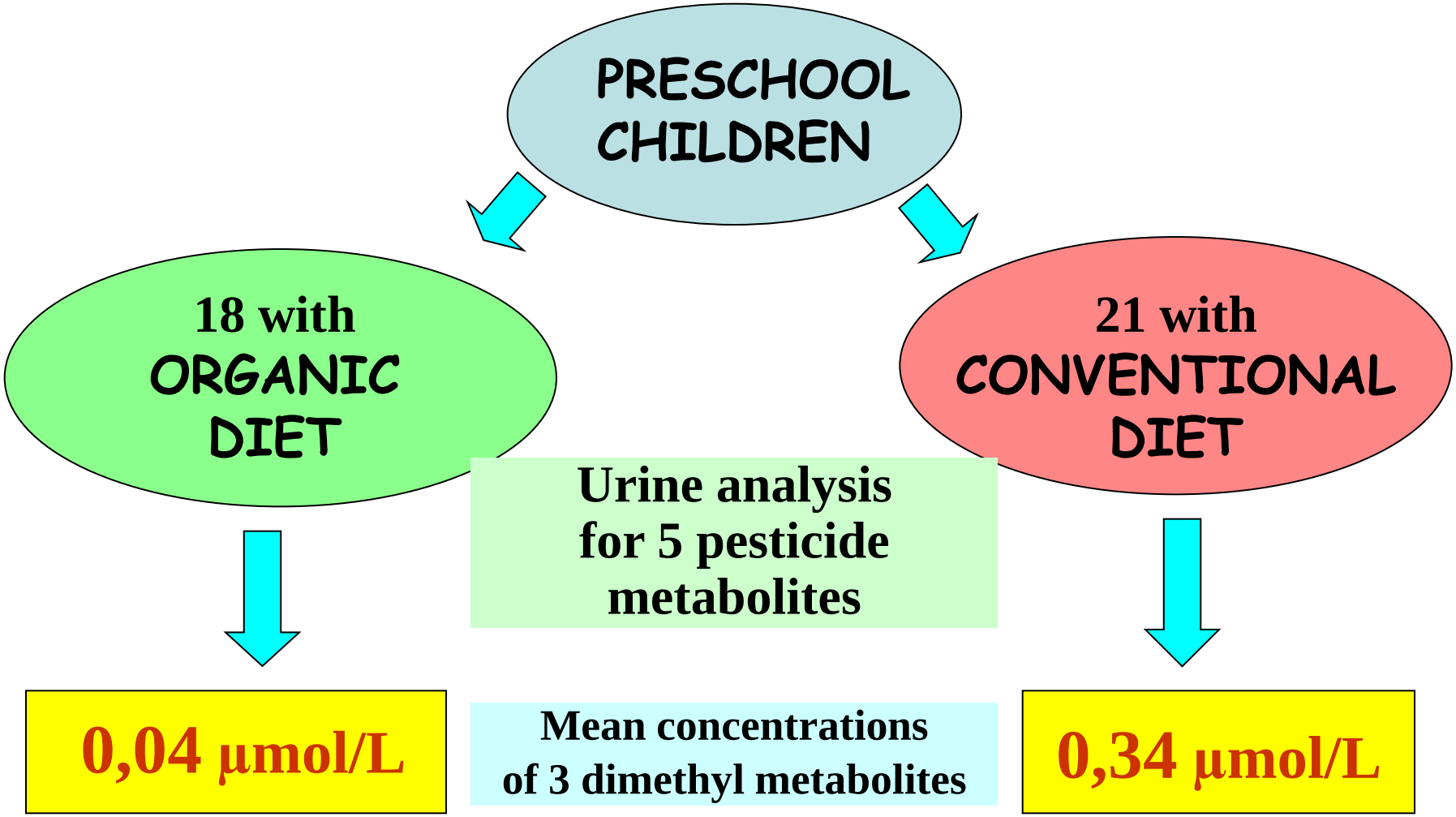
Comparison of the pesticide residues in crops from different production systems in several countries

Country	Organic farming % samples with residues	Integrated farming % samples with residues	Conventional farming % samples with residues
USA[1] 1993-2002	23	47	73
Belgium[2]	12	No data	49
Sweden 2002-2003[3]	3	11	44
Poland 2004[4]	0	50	44
Poland 2005[5]	7	47	28
Poland 2006[5]	5	48	21
Poland 2007	14[6]	No data	29[7]
Poland 2008	4[8]	No data	27[9]
Poland 2009	4[10]	No data	25[11]
Poland 2010	10,3[12]	No data	No data

[1] USDA (Baker et al. 2002)
[2] FSCA – FAVY 2001; big-scale studies 1995 – 2001 1995 – 2001
[3] National monitoring of plant origin food 2003
[4] Official control of national plant origin food 2005
[5] Gnusowski and Nowacka 2006
[6] Gnusowski et al. 2008
[7] Nowacka i in. 2008
[8] Gnusowski et al. 2009
[9] Nowacka et al. 2009
[10] Gnusowski et al. 2010
[11] Nowacka et al. 2010
[12] on the basis of item 4-11 and Gnusowski et al. 2011

Organophosphorus Pesticide Exposure of Preschool Childre with Organic and Conventional Diets

(Acc. to Curl et al. 2003)



CONCLUSION

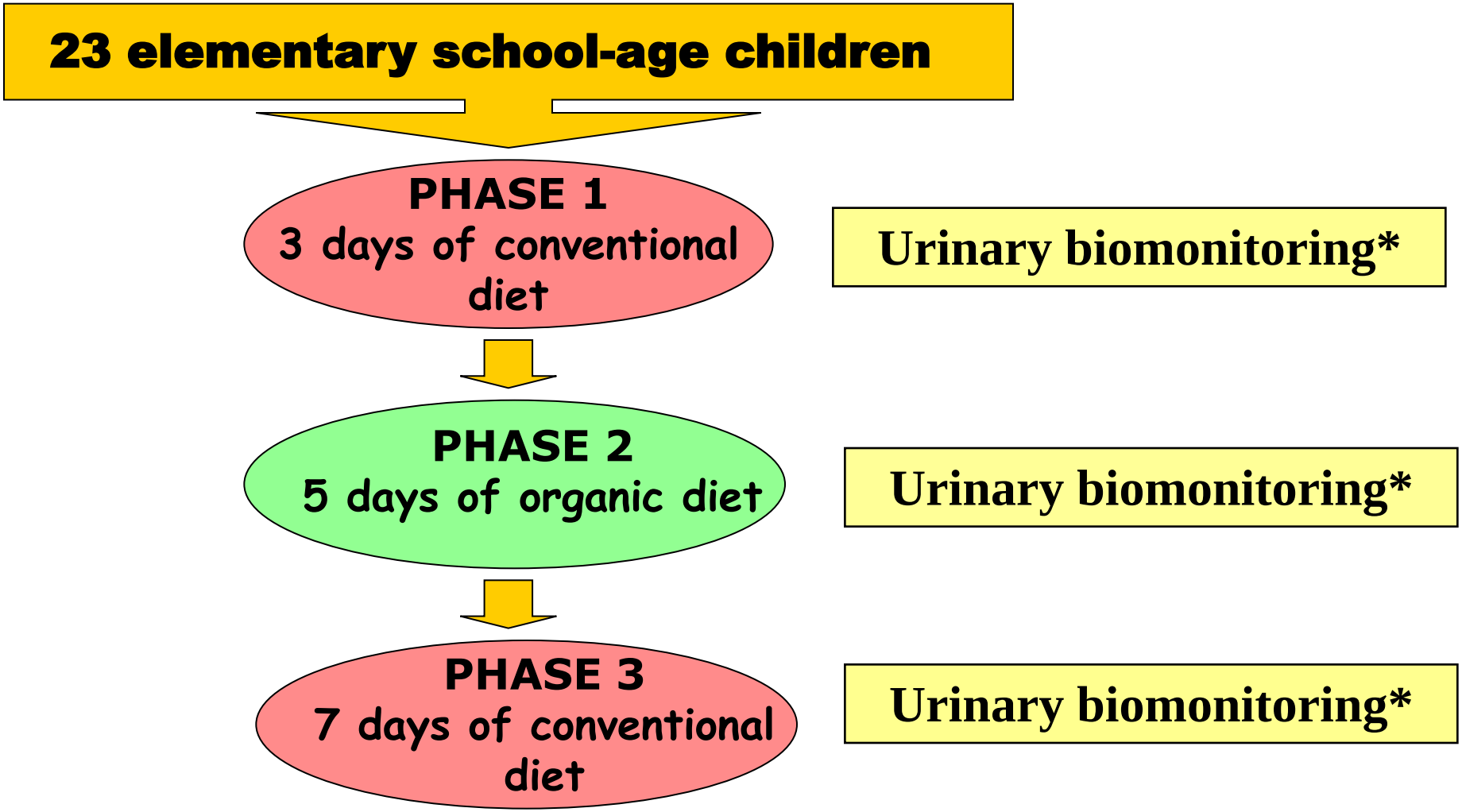
CONSUMPTION OF

ORGANIC PRODUCE

PROVIDE A SIMPLE WAY TO REDUCE CHILDREN'S EXPOSURE TO OP PESTICIDES

Acc. to Curl et al. 2003

Dietary organophosphorus pesticide exposure in a group of elementary school-age children (Lu et al. 2006)



*Monitoring of 5 OP pesticide urinary metabolites (MDA, TCPY, IMPY, DEAMPY, CMHC). Two spot daily urine samples were collected every day (first-morning and before-bedtime voids)

Organic Diets Significantly Lower Children's Dietary Exposure to Organophosphorus Pesticides

(Lu et al. 2006)

OP pesticides metabolite	Study phase	Frequency of detection (%)	Mean (µg/L)	Maximum (µg/L)
MDA*	1. (CONV)	60	2,9	96,5
	2. (ORG)	22	0,3	7,4
	3. (CONV)	60	4,4	263,1
TCPY**	1. (CONV)	78	7,2	31,1
	2. (ORG)	50	1,7	17,1
	3. (CONV)	78	5,8	25,3

*MDA – malathion dicarboxylic acid (LOD = 0,3 µg/L);

**TCPY – 3,5,6-trichloro-2-pyridinol (LOD = 0,2 µg/L)

Factors affecting the quality of raw food materials

- environmental conditions (clean or contaminated environment)
- method of farming (organic or conventional)
- conditions of plant production and animal breeding (proper or improper for the particular variety or breed)
- climatic- weather conditions
- storage and trade conditions of raw food materials

Factors affecting the quality of processed foods

- quality of raw food materials (from bad grain not possible to produce good flour)
- technology of processing and culinary treatment
- packing system
- storage and trade conditions of food products

What is „ORGANIC FOOD”?

- **Food produced according to certain, legally regulated production standards**
- **Production methods are friendly for environment, maintain biodiversity and soil fertility**
- **Social criteria are important (small farms, using local means of production, activation of the country areas)**

- **Organic agriculture excludes the use of synthetic fertilisers, pesticides, plant growth regulators**

- **Only natural organic fertilizers (compost, manure), green manures and biological crop protection methods are allowed**

- **Animal production excludes the use of antibiotics, hormones and GMOs**

- **Food processing protects nutritional quality, excludes synthetic food additives (preservatives, synthetic colour additives etc.)**

ORGANIC FARMING IN EU LEGISLATION

- The basic law on organic farming and processing, applying in the UE is **Regulation EEC No 2092/91** of 24 June 1991 **on organic production of agricultural products and idications referring there to on agricultural products and foodstuffs.**

- In August 1999 rules on production, labelling and inspection of the most relevant animal species (cattle, sheep, goats, horses and poultry) were also agreed - **Regulation (EC) No 1804/1999** of 19 July 1999. This agreement covers such issues as foodstuffs, disease prevention and veterinary treatments, animal welfare, husbandry practices and the management of manure.

- From 1 January 2009 **Council Regulation (EC) No 834/2007** of 28 June 2007 **on organic production and labelling of organic products and repealing Regulation (EEC) No 2092/91** will be in force.

Why do consumers look for organic food…???

M O T I V A T I O N

The loss of trust to conventional food produced on a massive scale

Food Scandals in Europe since 1996

Year	Scandal
1996	A probable link between BSE (bovine spongiform encephalopathy) and vCJD (Creutzfeldt-Jakob disease) has been established (Harris, 2000; Sy, 2003)
1998	Elevated levels of chlorinated dioxins in milk due to use of citrus pulp neutralized with waste of $Ca(OH)_2$ (Den Hartog, 2003)
1999	The Belgian PCB/dioxin incident. Polychlorobiphenyls (PCB) and dioxins were mixed into a tank of recycled frying oil, which was used for the production of animal feed (Bernard et al., 2002)
2010	Melamine in Chinese Nestle milk.
2011	Production and distribution of technical salt as common table salt in Poland
2011	Dioxins in German eggs and chicken meat
2011	Dioxins in chicken and pig flesh produced in Saxony and North Rhine-Westphalia. Fatty acids as a waste from fuel production (in Netherlands) were sold to company produced fat (in Germany and it was used to production animal feed)

Year	Scandal
2011	Organic mung seedling with E. coli?
2012	Contamination of beef and chicken meat by bacteriaes *Esherischia coli* and *Staphylococcus aureus* resistant on antibiotics in Germany
2012	re-filtration of used oil and distribution it as a clear one in China
2013	Horse meat in labeled as beef in Grate Britain and Northern Ireland

OTHER MOTIVATIONS

- **A strong conviction that organic food is safe for health**
- **The taste of organic food**
- **Care for natural environment**
- **Observance of animal welfare**

(Żakowska-Biemans, Gutkowska, 2003)

PROFILE OF ORGANIC CONSUMER

- **Well-educated, relatively young people**
- **Inhabitants of big cities**
- **Women with children**
- **Alergic patients**
- **Chronically ill people**
- **Vegetarians**

The main basis

Consumers' belief in higher health- and nutritional quality of organic products

Is the belief justified?

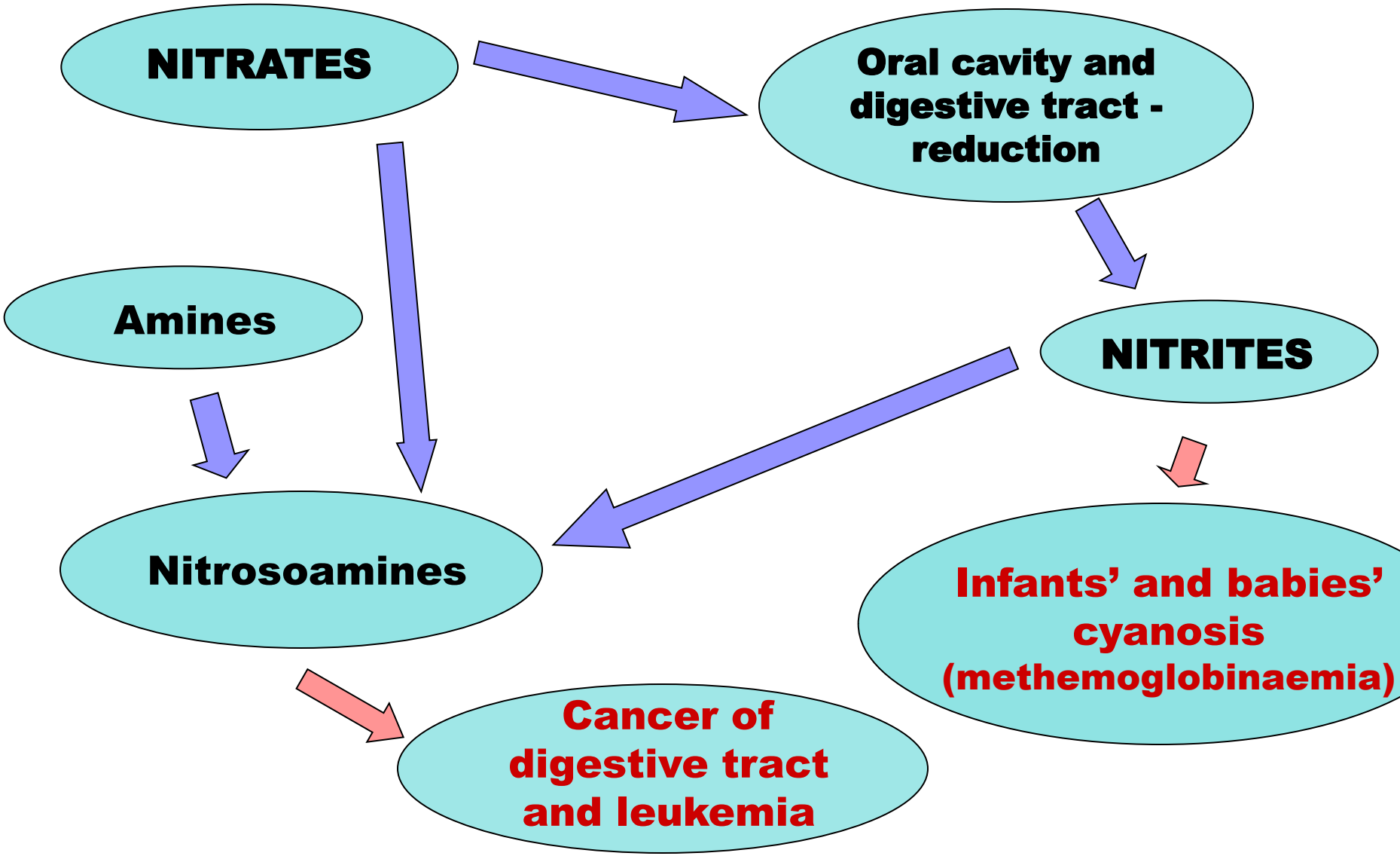
There are some empirical evidences

POSITIVES

- **Higher health quality/food safety**

Undiserable substances

NITRATES' EXCESS IS HARMFUL TO HUMAN HEALTH



Lower content of hormone residues, antibiotics, growth regulators, food additives…

in organic food

- **Higher nutritional value**

Total sugars in organic (ORG) and conventional (CONV) vegetables and fruit

Plants	difference in % org/conv	Author
beetroot	+ 0.72	Abele 1987
potatoes	- 0.90	Abele 1987
carrot	+ 3.96	Abele 1987
beetroot	+ 6.45	Zadoks 1989
tomato	- 8.52	Trybo et al. 2006
tomato	+ 9.31	Pieper and Barrett 2008
tomato	+ 2.09	Juroszek et al 2009
tomato	+ 13.19	Chassy et al. 2008
bell pepper	+ 0.54	Chassy et al. 2008
potatoes	+ 139.02	Cachoeira Stertz et al. 2005
apple	+ 6.04	Hecke et al. 2006
	+15.63	

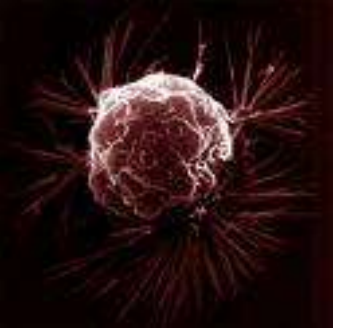
Reducing sugars' content in organic (ORG) and conventional (CONV) vegetables and fruit

Plants	difference in % org/conv	Author
apples	+ 5.00	Rembiałkowska et al. 2004
black currant	+19.71	Kazimierczak et al. 2007
black currant	+6,32	Kazimierczak et al. 2008
carrot	+ 14.61	Rembiałkowska 1998
tomatoes	+ 10.28	Rembiałkowska et al. 2005
tomatoes	+80.30	Rembiałkowska et al. 2007a
tomatoes	+41.67	Rembiałkowska et al. 2008
bell pepper	+ 40.00	Hallmann et al. 2007
bell pepper	+39.23	Hallmann and Rembiałkowska 2007
carrots	+ 2.99	Rembialkowska and Hallmann 2007
red onion	+89.00	Hallmann and Rembialkowska 2007
onion	+ 91.76	Hallmann and Rembiałkowska 2006
	+ 36.78	

Sugar content in sugar beets [% f.m.]

	Farm		
Year	Conventio-nal	Integrated	Organic
1980	16,4	16,2	16,4
1981	15,7	15,7	16,1
1982	16,2	16,7	17,3
1983	15,8	15,9	16,5
1984	13,6	15,8	16,3
Mean	15,5	16,1	16,5

Zadoks, 1989



Factors affecting the incidence of cancer

Factor	Effect on cancer
Energy intake	Increased intake increases the risk of certain forms of cancer
Fat	Weak correlation fat intake and cancer
Fibre	Fruit and vegetable fibres reduce the risk of the large intestine cancer, whilst fibre from cereals increases it
Selenium	Protects against intestinal and breast cancer
Vitamin A / carotenoids	Often positive correlation with certain forms of cancer
Vitamin C	Seems to protect against a range of cancers. It is probably other factors in fruit that have the primary effect
Vitamin E	No significant effect

Willet 1996

Note. Vegetables have generally proved to protect against many forms of cancer

Mineral compounds in organic and conventional vegetables

(Worthington 2001)

vegetable	Mineral compounds*		
	Iron	Magnesium	Phosphorus
Lettuce	+17	+29	+14
Spinach	+25	- 13	+14
Carrot	+12	+69	+13
Potatoes	+21	+5	0
Cabbage	+41	+40	+22

***„+”** and **„-” determine % differences in the content of each compound in organic vegetable in comparison with conventional vegetable.*

Dry matter content in organic and conventional vegetables (Rembiałkowska 2000)

VEGETABLE	CULTIVAR	YEAR	ORGANIC	CONVENTIONAL
Potatoes	different cultivars, mixed	1991 - 1993	22.4 a[1]	21.1 b [1]
Potatoes	Bryza	1994	21.43 a [1]	20.21 a [1]
Potatoes	Sokół	1994	20.64 a	20.79 a
Potatoes	Sokół	1995	21.91 a	20.21 a
Potatoes	Ania	1995	24.12 a	21.60 b
Potatoes	Anielka	1996	24,3 a	23,3 b
Carrot	Regulska	1996	15.22 a	14.11 a
Carrot	Monanta	1997	11.55 a	11.10 a
Cabbage	Atria F1	1997	8.37 a	7.25 b
Red beet	*	1997	16.76 a	13.86 b
Carrot	*	1997	11.78 a	11.42 a
Potatoes	*	1997	18.08 a	16.85 b

[1] (a – a) = difference statistically insignificant; (a – b) = difference statistically significant

* Vegetables from organic shops (cultivars not known)

Dry matter content in organic and conventional vegetables
Literature review

	difference in % org/conv	
potatoes	+ 19.57	Stertz et al.2005
tomatoes	- 5.31	Thybo et al. 2006
carrot	+ 23.83	Fleck et al. 2001
strawberry	+ 7.23	Cayuela et al.1997
	+ 11.33	

Dry matter content in organic and conventional vegetables in Organic Food Division (WULS)

vegetables	Difference in % org/conv	source
tomato	- 0.27	Rembiałkowska et al. 2005
tomato	- 2.81	Rembiałkowska et al. 2005a
tomato	+ 1.83	Hallmann and Rembiałkowska 2007
tomato	+ 55.02	Hallmann and Rembiałkowska 2007a
tomato	+ 1.83	Hallmann and Rembiałkowska 2008
tomato juice	+ 35.45	Hallmann and Rembiałkowska 2008.
bell pepper	+ 14.73	Rembiałkowska et al. 2005
bell pepper	+ 13.37	Hallmann et al. 2007
bell pepper	+ 3.87	Hallmann and Rembiałkowska 2007
bell pepper	+ 3.92	Hallmann et al 2008
carrot	- 0.95	Rembiałkowska and. Hallmann 2007
onion	+ 7.52	Hallmann and Rembiałkowska 2006.
red onion	+ 5.00	Hallmann and Rembiałkowska 2007
blackcurrant	+ 3.41	Kazimierczak et al. 2007
blackcurrant	+ 2.75	Kazimierczak et al. 2008
	+ 9.64	

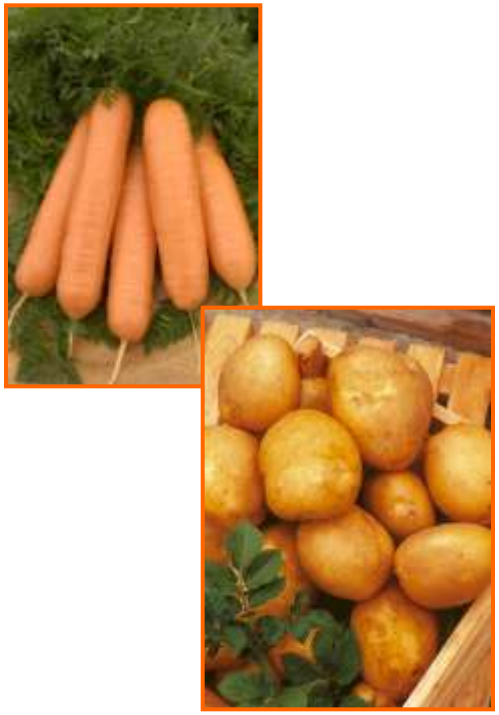
Mass loss of several vegetables (in % of basic mass) after their storage in dependence on fertilisation type (after Samaras 2008)

Vegetable	Mass loss of rotten vegetables		
	Mineral fertilisation	Organic fertilisation	Difference in % org/conv.
Carrot	45.6	34.6	+ 31.79
Kohlrabi	50.5	34.8	+ 45.11
Beet root	59.9	30.4	+ 97.04
Potatoes	29.6	15.6	+ 89.74
Average	**46.4**	**28.9**	**+ 60.55**

- **Better storage quality of organic vegetables (Higher content of dry matter, lower losses during storage period)**

Storage losses of vegetables and potatoes from organic and conventional farms (Bulling 2007)

	carrots		potatoes		various fruits and vegetables (average)	
	ORG	CON	ORG	CON	ORG	CON
Number of studies	15	15	22	22	53	53
Storage losses in % of initial mass	33	40	22	30	28	38



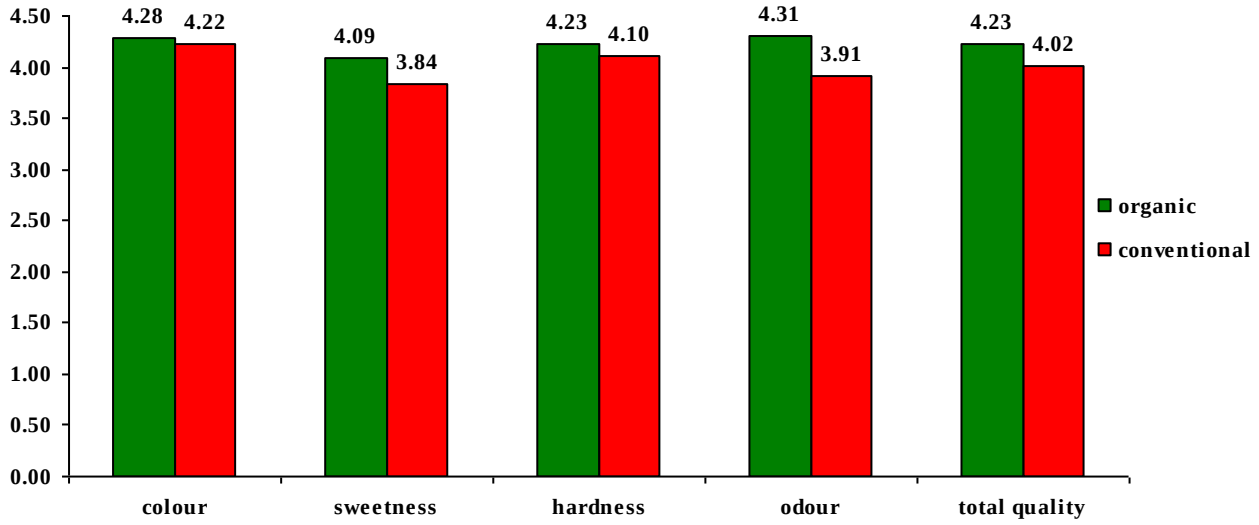
(Bulling 2007)

Selected sensory attributes of organic and conventional carrots (Haglund et al. 1999)

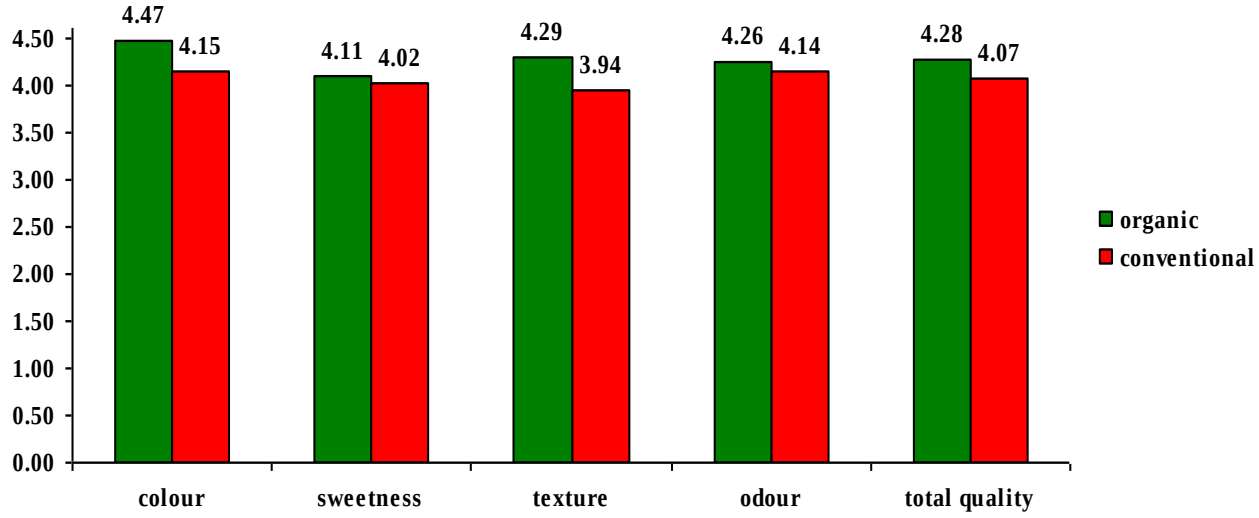
sensory attributes	growing system				variety			
	conventional	organic	difference in % org/conv.	effect of growing system	Narbonne	Newbourgh	Nandor	effect of variety
hardness	4.8	5.3	+ 10.4	**	5.4	4.7	5.1	***
crunchiness	6.7	6.0	- 11.7	**	5.7	7.3	6.1	***
sweetness	6.3	5.9	- 6.8	**	5.8	5.9	6.7	***
carrot-taste	6.0	5.2	- 15.4	***	5.2	5.8	5.8	**

Selected sensory attributes of lettuce (Mello et al. 2003)

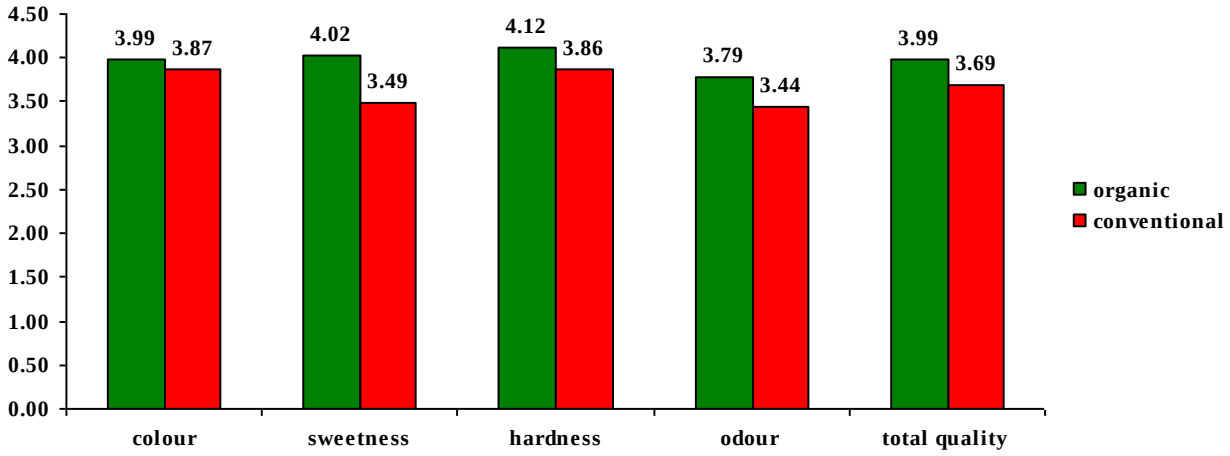
	organic	conventional	difference in % org/conv
colour	9.29	9.56	- 2.91
gloss	9.29	9.24	+ 0.54
enzymatic brownig sensivity	9.66	9.76	- 1.04
lettuce odour	9.79	9.23	+ 6.07
other odour	9.77	9.57	+ 2.09
texture	9.63	9.44	+ 2.01
taste	9.64	9.49	+ 1.58



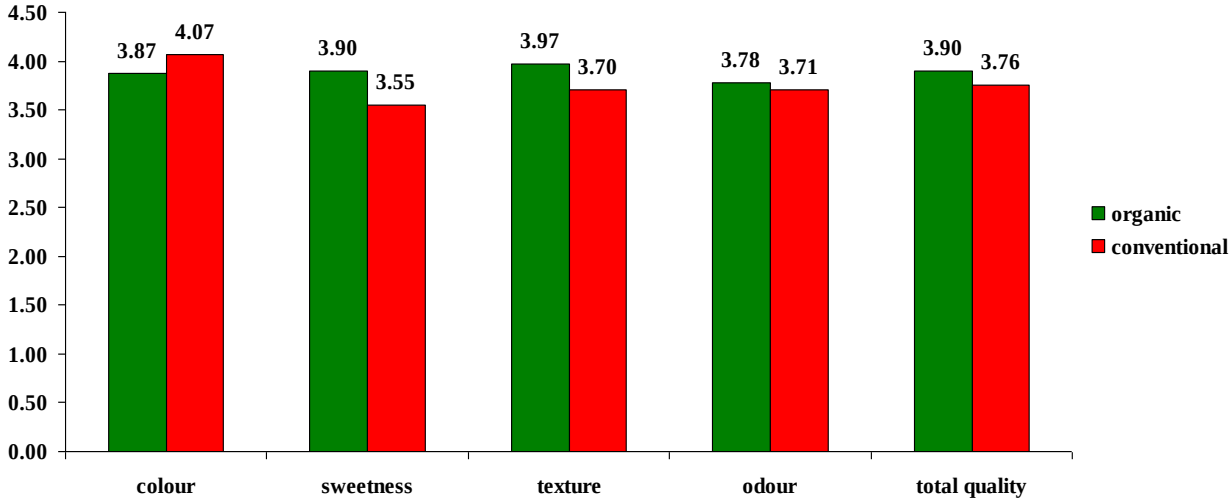
Sensory evaluation of fresh carrot Regulska from organic and conventional cultivation in 1997



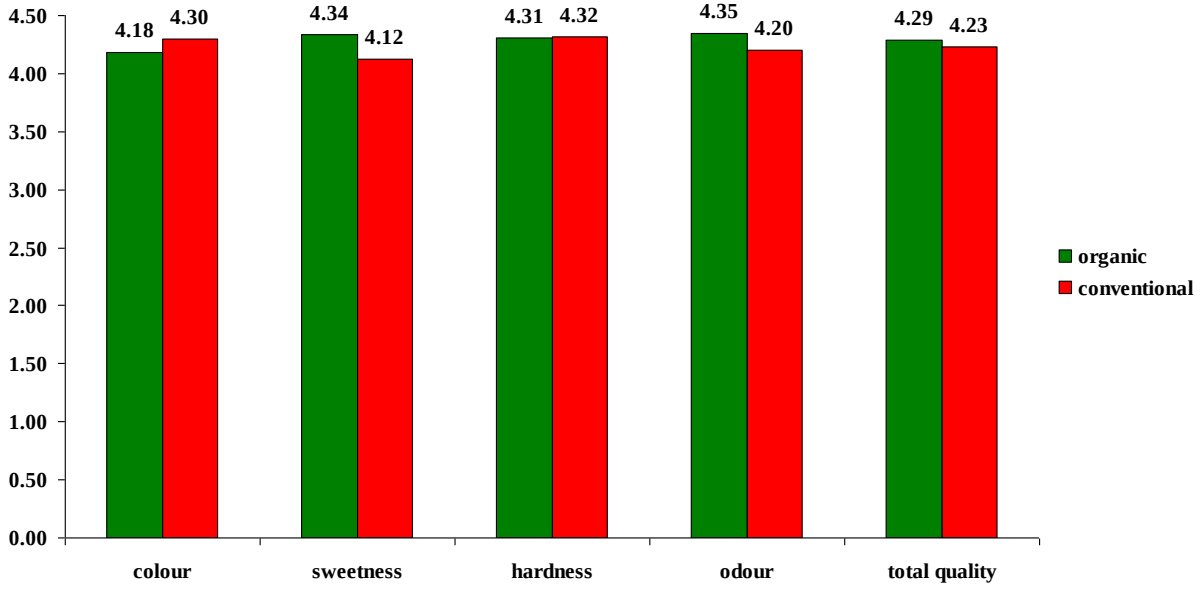
Sensory evaluation of canned carrot Regulska from organic and conventional cultivation in 1997



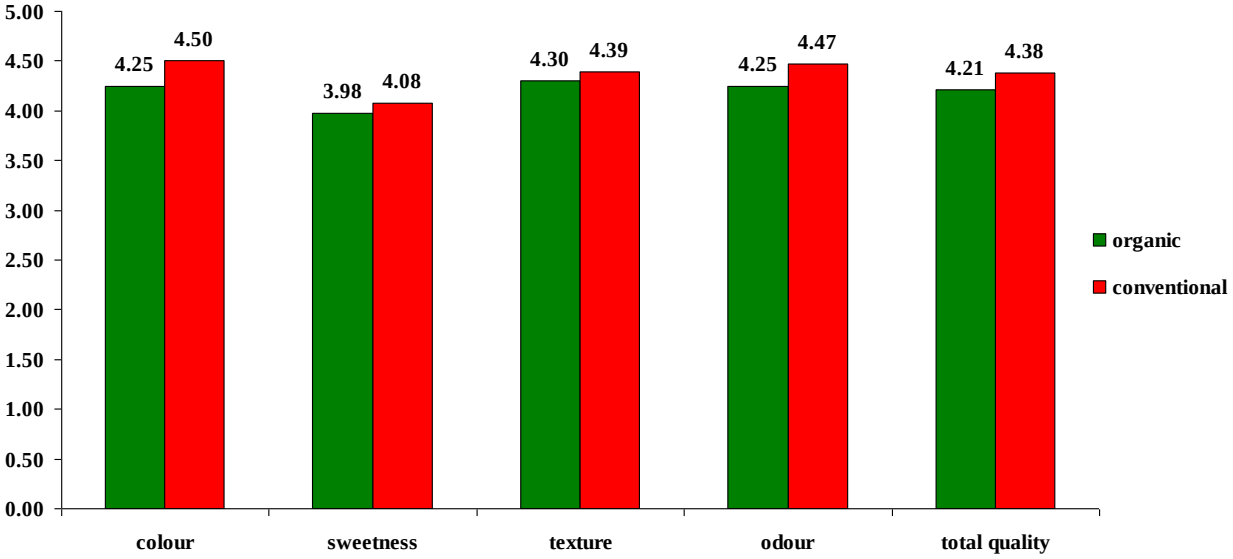
Sensory evaluation of fresh carrot Monanta from organic and conventional cultivation in 1997



Sensory evaluation of canned carrot Monanta from organic and conventional cultivation in 1997

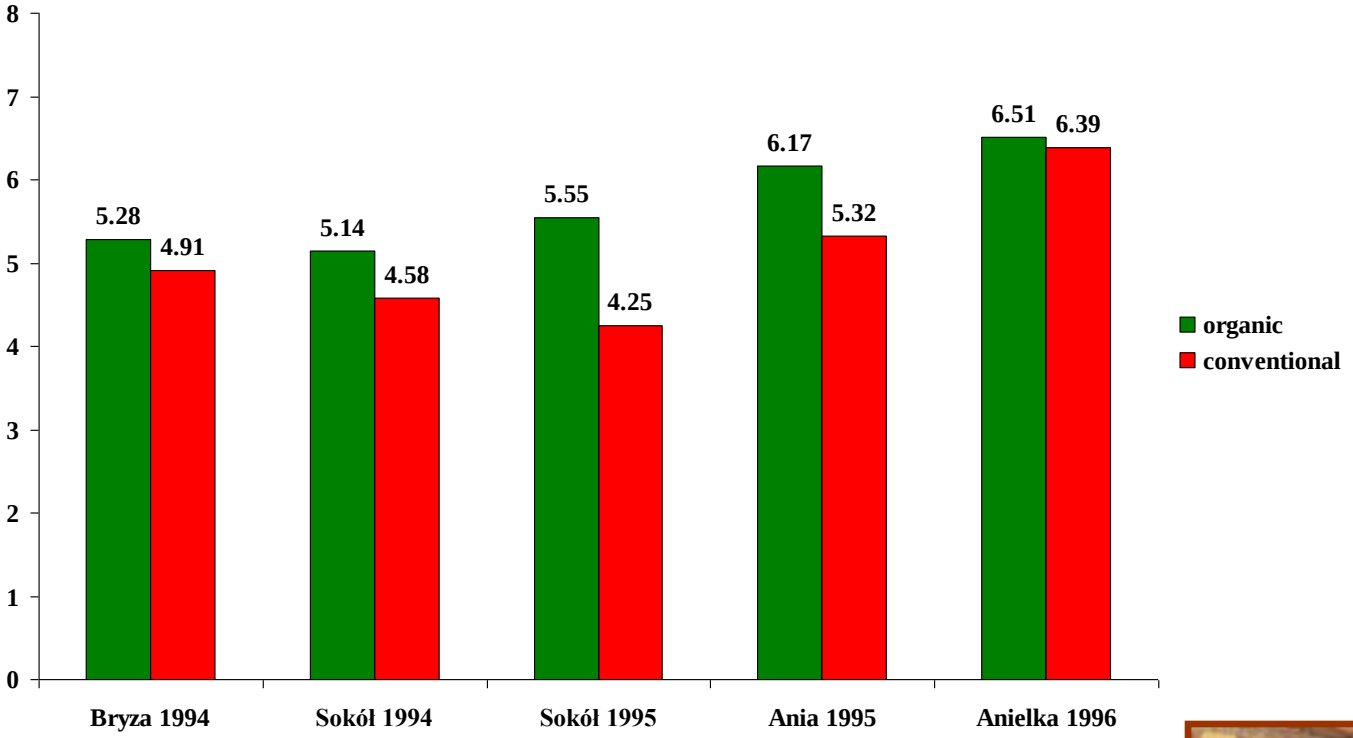


Sensory evaluation of fresh withe cabbage Atria from organic and conventional cultivation in 1997

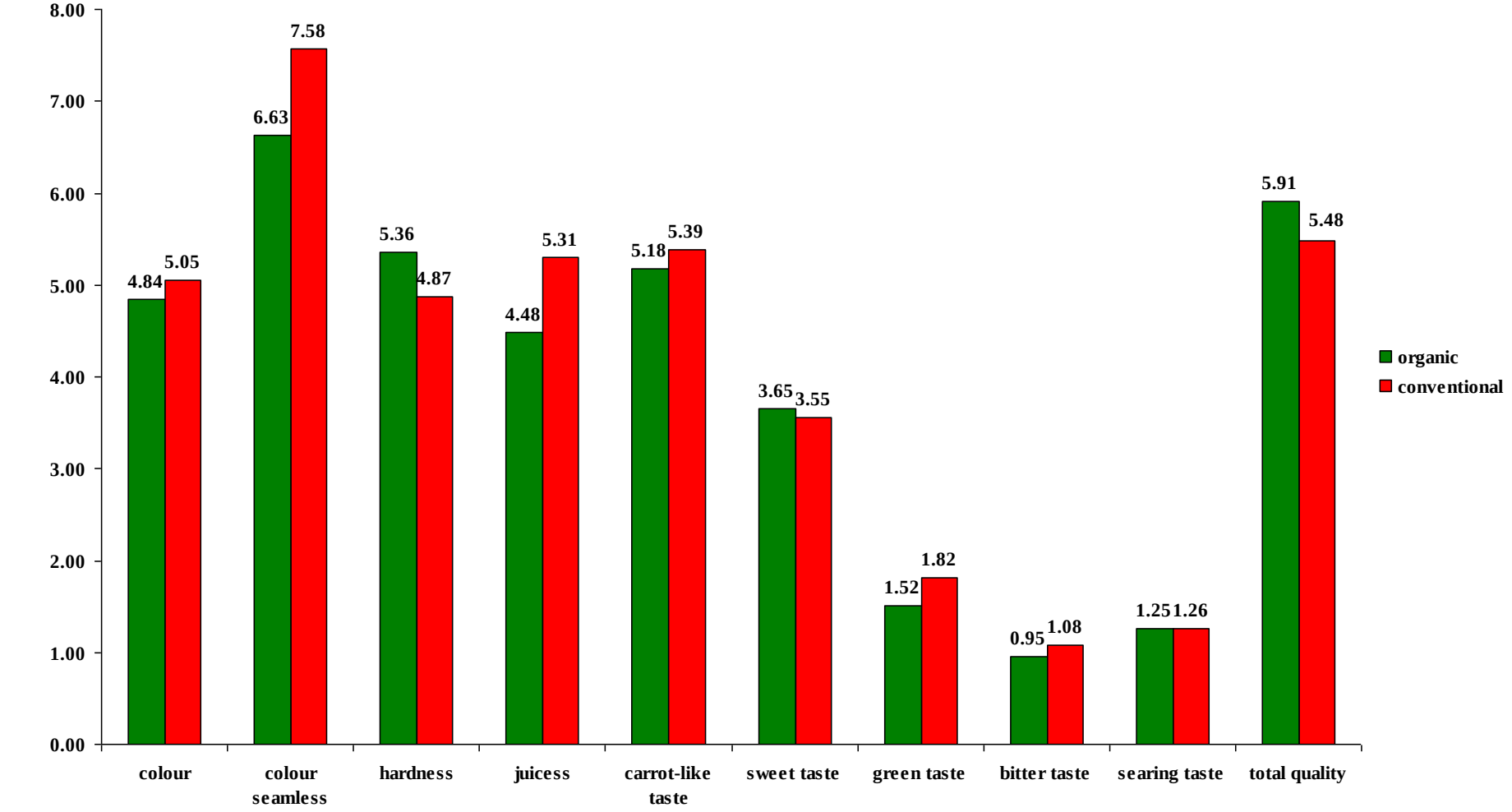


Sensory evaluation of sauerkraut withe cabbage Atria from organic and conventional cultivation in 1997

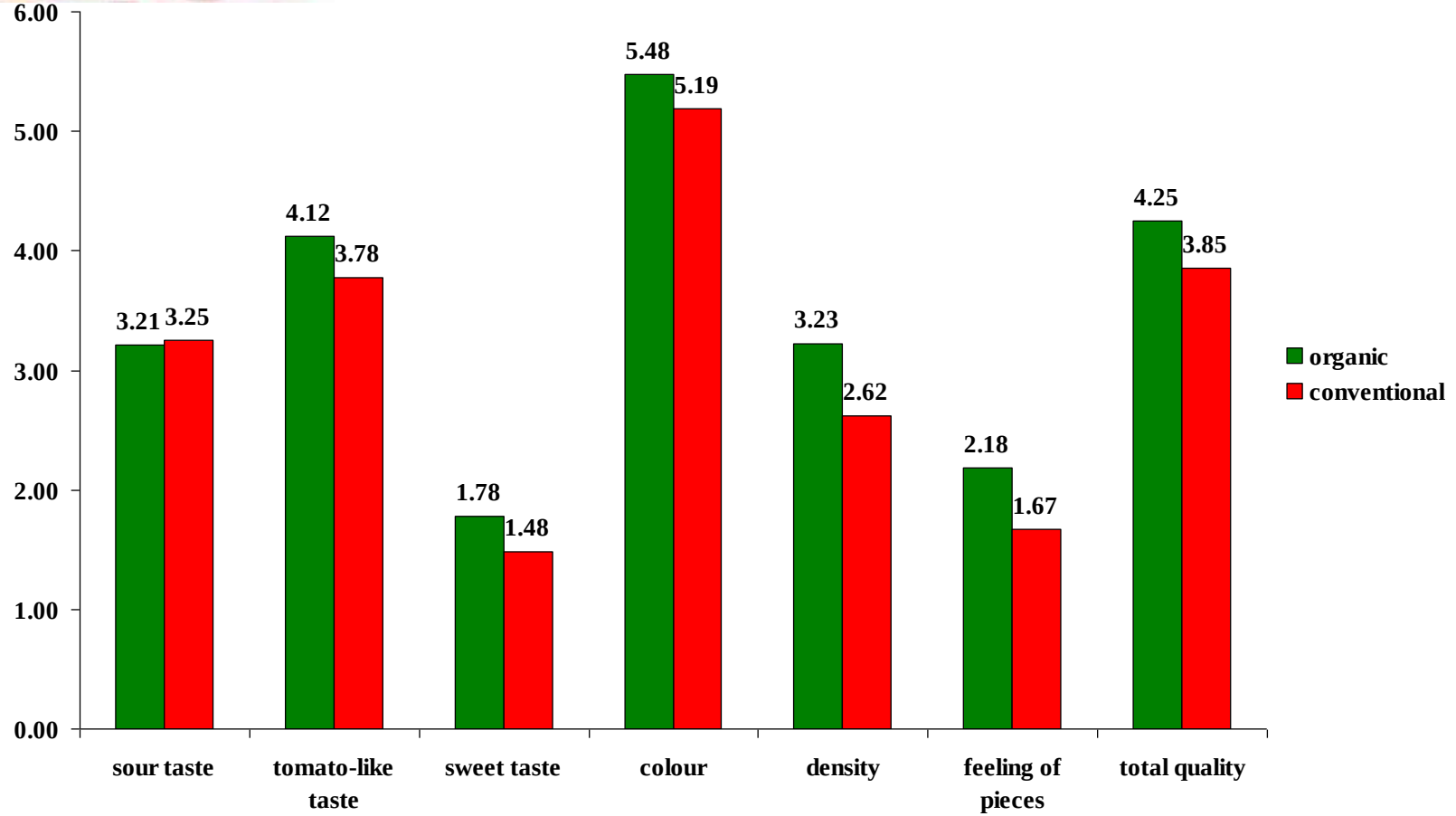
Sensory evaluation of selected potato cultivars from organic and conventional cultivation



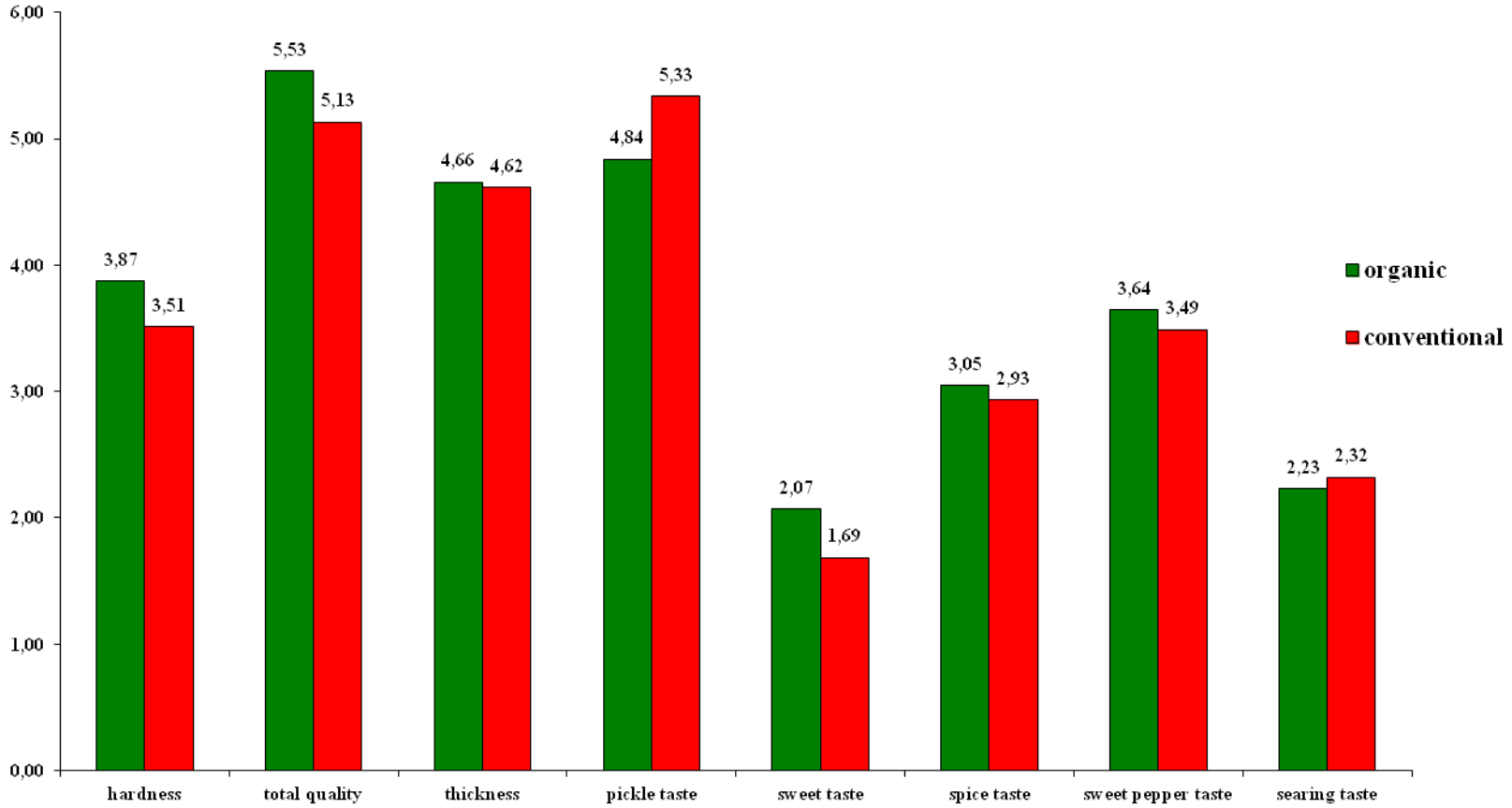
Sensory evaluation of fresh carrot from organic and conventional cultivation



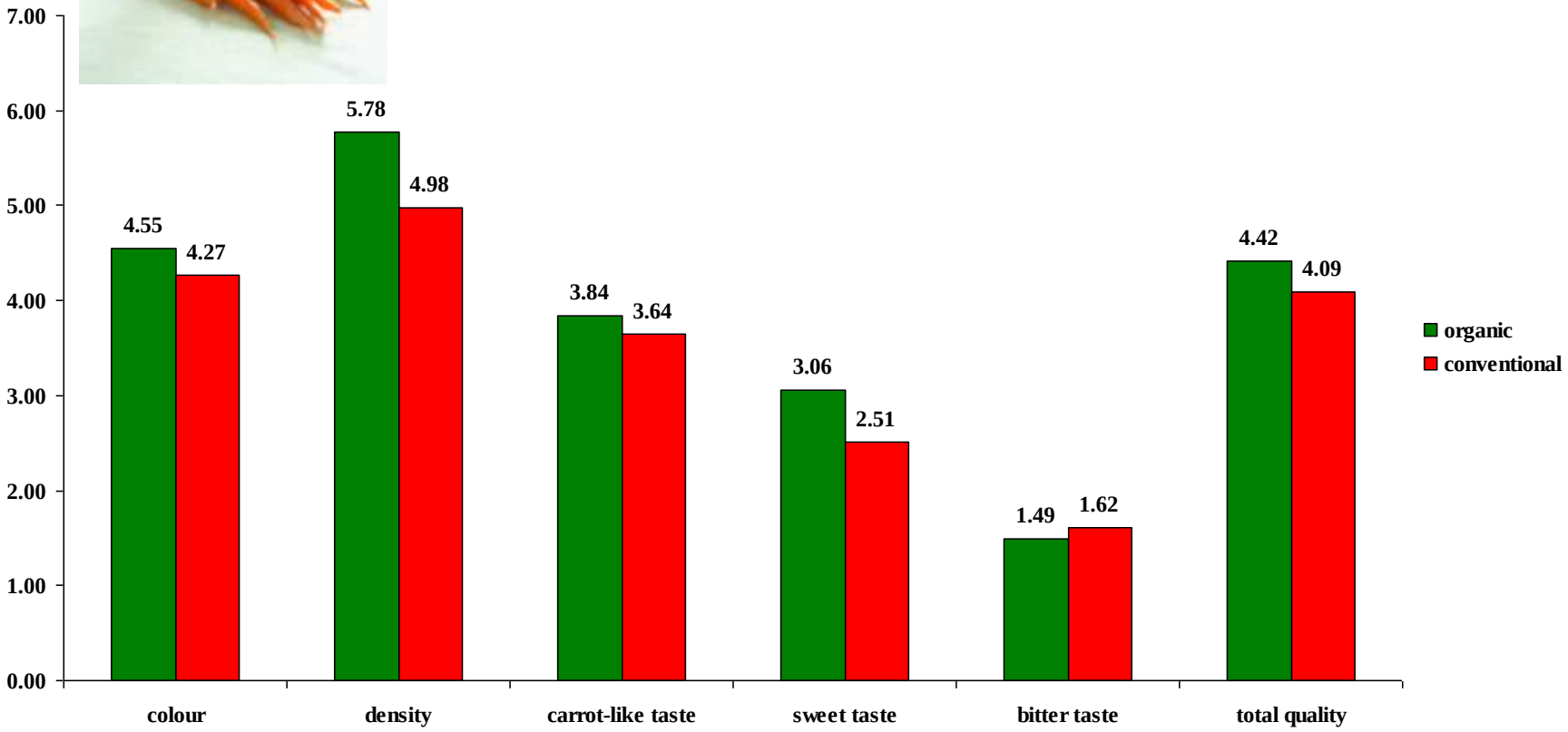
Sensory evaluation of tomato juice from organic and conventional cultivation



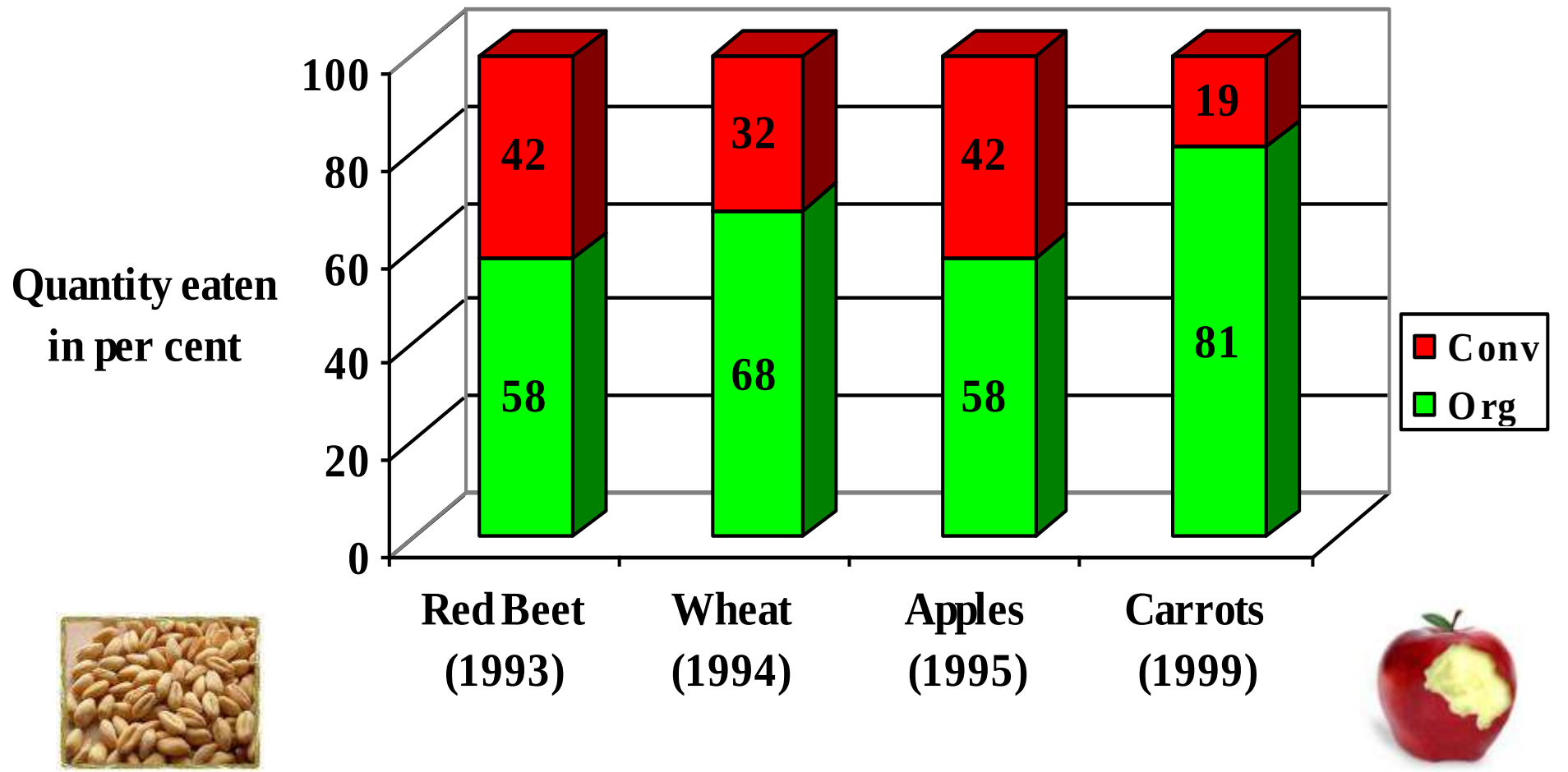
Sensory evaluation of pickled bell pepper from organic and conventional cultivation



Sensory evaluation of carrot juice from organic and conventional cultivation



Rat studies on choice of organic vs. conventional feed



According to: Maeder 1993, Velimirov 2001, Velimirov 2002.

THANK YOU