Nutritional and sensory value of conventionally vs organically grown Chinese radish (*Raphanus sativus* L. var. *longipinnatus*)

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Abstract

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The nutritional and sensory value of Chinese radish, cv. Jarola F1, grown in organic and conventional systems was evaluated. The experiments were based on certified organic land and conventional land of the Czech University of Life Sciences Prague at the experimental station of Troja. Radish was grown in two spacings. Radish from the organic cultivation system exhibited a significantly lower dry matter content compared to the conventional production, 62.4 g/kg and 68.9 g/kg, respectively. This can be explained by growing under unwoven textile. Furthermore, radish cultivated organically had a significantly lower content of monosaccharides (17.2 mg/kg, while the conventional production contained 26.1 mg/kg) and significantly higher contents of nitrates. The content of vitamin C in organic production tended to be higher (212 mg/kg, in conventional production 169 mg/kg). The crude fibre content or the content of minerals was not significantly affected by the growing system. Growing spacing did not affect the nutritional value. Organically produced radish had better sensorial evaluation.

Keywords: dry matter; monosaccharides; vitamin C; nitrates; minerals

The growing demand for organic production is motivated by healthier diet – limiting the intake of undesirable substances such as pesticide residues, chemical fertilizers, heavy metals and food supplements. From the marketing point of view, organic growing offers higher nutritional content important to humans or higher sensory value. However, the results of research in this direction often diverge. This can be explained by different soil and climatic conditions. Most often, organically grown vegetables contain higher dry matter (Bünnagel 1992; Heaton 2001; Bognár 2002; Tauscher et al. 2003). Higher fibre content in organic growing of tomatoes and carrots was listed by Evers (1989) and Kerpen (1988) (cit. Woese et al. 1997). These results, however, were mostly one – year based. Worthington (2001) reviewed 41 studies on the control of organic and conventional production. He found out that the organic production of spinach, lettuce, carrots, tomatoes and cabbage contains on average 27% more vitamin C, 21.1% more iron, 29.3% more magnesium and 13.6% more phosphorus than conventional cultivation of these vegetables.

The lower content of nitrates is very often reported as an advantage of organic production. Woese et al. (1997) also evaluated 41 studies and concluded that the nitrates content in vegetables from organic farming systems, or when the vegetables were grown with organic fertilizers, was lower than in vegetables from conventional farming system. Magkos et al. 2006 (cit. Givens et al. 2008) reported that vegetables grown in the organic farming system contained about 15–50% less nitrates than conventionally grown vegetables. However, some studies have shown the opposite trend. An increased nitrates content in organically grown tomatoes, spinach, chicory and lettuce was found by Malmauret et al. (2002), which can be explained according to Givens et al. (2008) by other factors during cultivation – such as variety, soil type, time of planting and harvesting, irrigation, water quality, climate, storage conditions and post-harvest treatment.

The evaluation, which is the result of the EU project "Quality Low Input Food" in Hajšlová and Schulzová (2006) suggested that organic production resulted in about 10–50% higher content of vitamin C and lower nitrates content, in 20–50% higher content of phenolic compounds, in more than 90% lower content of pesticides, however in about 10–50% less carotenoids.

The aim of this study is to compare the nutritional and sensory value of radish grown organically to that grown in a conventional system of cultivation. Radish was chosen as it is a vegetable with short vegetation period and is often cultivated in organic systems.

MATERIAL AND METHODS

The experiment was set up in 2007 and 2008 at the Czech University of Life Sciences Prague, the experimental station of Troja (50°7'21.198"N, 14°23'56.359"E). The station is located at the altitude of 195 m above sea level and lies on the right bank of the Vltava river, which ensures optimum air humidity during summer for growing of vegetable species demanding air humidity. The average annual temperature is 9.3°C and total precipitation is 331.9 mm (Švachula 1992). Temperature, solar radiation and precipitation conditions during autumn sowing in 2007, spring sowing in 2008 and autumn sowing in 2008, are in Table 1.

The experiments were based on certified organic land (in 2007 the land was in its first year after the transitional period) and land with conventional cultivation. Both plots were separated by a strip of grass.

The previous crop on the land with organic cultivation in both years of this experiment was green manure – mix of legumes and cereals (field peas, oats, wheat – which are considered good to precede). On the land with conventional cultivation there was also green manure in the first year of the experiment as previously and in the second year of the experiment spring culture was followed by

Table 1. Temperature, solar radiation and precipitation conditions during the production terms

Production term	Temperature (°C)				Total precipitations (mm)	Total solar radiation (kJ/m^2)
	max	min	average	total average		
Autumn sowing 2007						
From August 15	29.7	10.6	18.7	307.8	28.5	259,409
September	25.9	2.9	12.8	384.6	74.2	315,756
Till October 22	20.6	–1.3	9.3	203.8	10.9	176,093
Total				896.2	113.6	751,258
Spring sowing 2008						
From March 26	16.6	–1.6	6.5	38.9	0.2	79,647
April	22.2	–0.6	8.8	266.8	58.2	360,211
May	30.2	4.9	14.7	458.3	56.6	582,143
Till June 5	28.3	10.1	19.4	555.5	18.3	102,423
Total				1,319.5	133.3	1,124,424
Autumn sowing 2008						
From August 14	30.4	8.2	17.8	319.8	49.3	278,105
September	29.3	3.1	13.3	401.5	17.9	329,216
Till October 14	20.7	2.4	11.1	155.8	9.3	101,892
Total				877.1	76.5	709,213

black fallow and autumn culture after early potatoes.

In 2007, when there was green manure on both lands as previous crop, high amounts of nutrients were found, so the conventional plot was not fertilized. The observed content of nutrients on both the organic and conventional land was in mg/kg of soil: P = 278.0, K = 525.0, Ca = 1,650.0, Mg =140.0, N_{min} = 41.0, and was evaluated as very high for all elements. pH of soil was 6.3–6.8. In 2008, nutrients in the form of mineral fertilizers were added in conventional cultivation in amounts: 22 kg P, 66 kg K and 24 kg Mg/ha. Nitrogen was not used for fertilizing as its content in the soil was high – 180 kg/ha.

The experiment was conducted with Chinese radish (daikon), *Raphanus sativus* L. var. *longipinnatus* cv. Jarola F1 (produced by Semo Smržice, Smržice, Czech Republic). Due to the absence of organic seeds in the market a standard untreated seed was used for organic cultivation. For conventional cultivation, the seed was desinfected with the active substance thiram.

Sowing dates: August 15, 2007, March 26, 2008 and August 14, 2008. Seeds were sown into nests of three seeds and after emergence thinned to one plant. The experiment was established in 3 repetitions in the spacing 0.20 × 0.35 m (in one repetition of the 150 plants) and in the spacing 0.30 × 0.35 m (100 plants per repetition).

For the organic cultivation, according to literature (Eckhard, Reyhaneh 2003) the soil was covered with unwoven textile PP 17 g/m^2 after sowing. When necessary, the plot was mechanically cleaned of weeds. The unwoven textile was left there until harvest.

For the conventional cultivation, a contact herbicide Gramoxone was applied on the radish before emergence – the active substance is paraquat. The growth was as necessary mechanically cleaned of weeds during the vegetation period. As for pests on the radish, some *Delia platura* occurred, but no protection was applied because no insecticides are allowed for radish.

Irrigation was carried out during dry periods in both plots by micro sprayer. Periods of harvest: October 22, 2007, June 5, 2008 and October 14, 2008.

Variants of experiment. Organic and conventional growing, two spacing, 3 sowing dates. For the analysis of nutrients, three market pieces of radish were selected for each variant and repetition. Number of analyses n = 6 of each variant. Furthermore, some pieces of radish were chosen for sensory evaluation.

The crude fibre content was determined from dried samples weighing 1 g each wrapped in bags (FibreBags) using the method of oxidative hydrolysis according to Henneberg-Stohmann (Javorský et al. 1987). The chemicals used were sulphuric acid, potassium hydroxide and petroleum ether. In addition to common laboratory equipment, a muffle furnace was used to anneal the samples at 600°C and also a FibreBag carousel.

The contents of monosaccharides (glucose and fructose) were determined using a reflectometer RQflex (Merck, Darmstadt, Germany). The test strip was soaked in a mixture of fresh radish juice, distilled water and TS-1 agent and then inserted into the apparatus calibrated according to Merck standard.

The content of vitamin C was determined by high performance liquid chromatography RP-HPLC (ECOM, České Meziříčí, Czech Republic) in Separon SGX colon with detection by ultraviolet area 254 nm. The detection was done on 10 g of a sample that was carefully homogenised by adding some oxalic acid. The volume of the injection was 20 μl. The used liquid chromatograph: analytical pump LCP 4000.11, analytical injection loop valve D, outer loop 20 μl, micro portioner Hamilton 50 μl, UV-VIS detector LCD 2082, computer integrator CSW 2k, analytical column CGC 3 × 150 Separon CGXC18, 7 μm, precolumn CGC 3 × 30 Separon CGXC18, 7 μm.

The content of nitrates was determined by ion-selective electrode from Šenkýř – ISE (according to Javorský et al. 1987). In order to determine the content of nitrates the samples were frozen after harvest, the sample portion weighed 100 g. The samples were puréed in a solution of aluminium sulphate and further processed. Measurement was done using the device Ionalyzer MPH 171 (Monokrystaly, Turnov, Czech Republic).

The contents of potassium, magnesium, calcium and sodium were established by capillary isotachophoresis. During one analysis cycle lasting about 15 min all of these elements were determined simultaneously. Measurement was done on a one-dimensional capillary analyser (Recman, Ostrava, Czech Republic) (Kvasnička 2008).

Sensory evaluation was carried out immediately after the harvest. It included four samples from organic and four from conventional production. In the fall of 2007, the samples of radish were re-

Table 2. Dry matter and crude fibre content (means ± standard deviation) in radish from organic and conventional cultivation

Production term/spacing		Dry matter (g/kg)		Means		Crude fibre (g/kg)		Means	
		O	K	(O + K)/2	Σ(A + B)/4	O	K	(O + K)/2	Σ(A + B)/4
1.	A	64.5 ± 1.8	73.2 ± 2.8	68.8	71.1[a]	5.5 ± 0.2	6.2 ± 0.4	5.8	6.0
	B	69.6 ± 2.8	77.4 ± 3.8	73.5		6.0 ± 0.4	6.4 ± 0.1	6.2	
2.	A	62.0 ± 1.4	66.2 ± 1.2	64.1	62.9[b]	7.2 ± 0.6	6.6 ± 0.4	6.9	6.5
	B	59.8 ± 3.8	63.8 ± 4.2	61.8		6.2 ± 0.6	6.0 ± 0.6	6.1	
3.	A	58.2 ± 1.6	65.6 ± 4.3	61.9	62.8[b]	5.3 ± 0.1	6.0 ± 0.8	5.6	5.6
	B	60.3 ± 2.3	67.3 ± 5.8	63.8		5.3 ± 0.1	6.1 ± 0.3	5.7	
Mean		62.4[a]	68.9[b]			5.9	6.2		

production terms (terms of sowing): (1.): 15. 8. 2007, (2.): 26. 3. 2008, (3.): 14. 8. 2008; A – spacing 0.20 × 0.35 m, B – spacing 0.30 × 0.35 m; O – organic cultivation; K – conventional cultivation; different letters represent significant differences at P = 0.05 among the methods of cultivation (columns) and terms of sowing (lines)

viewed by 43 respondents, in autumn 2008 by 34 respondents. Rated descriptors according to Kopec and Horčin (1997) were: appearance; flesh colour; smell; intensity of the smell; taste – sweet, bitter, spicy, undesirable; overall flavour; tenderness; juiciness; overall impression. A lower number means higher sensory descriptor value.

The significance between the means of main effects (method of cultivation, spacing and terms of sowing) was evaluated using the LSD test at P = 0.05.

RESULTS AND DISCUSSION

In contrast to literature (Bünnagel 1992; Tauscher et al. 2003), a significantly higher amount of dry matter was observed in conventionally grown radish (Table 2). The different findings in literature can be explained by higher air humidity under the unwoven textile used for radish growth in the organic variants. Significantly higher dry matter during the autumn planting in 2007 compared to the two other periods can be explained by differences in climatic conditions (Table 1). The effect of stand density (number of pieces per unit area) on dry matter content was minimal.

The crude fibre content was not affected by the growing system (Table 2). Lower values were found in autumn 2007 and 2008, compared to the spring term of 2008. Benoit and Ceustermans (1992) reported that at lower intensity of solar radiation plants had a lower amount of fibre; this corresponds to a lower amount of solar radiation detected in autumn 2008 (Table 1).

Table 3. Content of monosaccharaides and vitamin C (means ± standard deviation) in radish from organic and conventional cultivation

Production term/spacing		Monosacharides (g/kg)		Means		Vitamine C (mg/kg)		Means	
		O	K	(O + K)/2	Σ(A + B)/4	O	K	(O + K)/2	Σ(A + B)/4
1.	A	20.7 ± 3.4	34.4 ± 2.3	27.5	29.6[a]	347 ± 45	160 ± 65	253	254
	B	26.4 ± 1.5	37.2 ± 1.1	31.8		392 ± 49	117 ± 48	254	
2.	A	11.8 ± 1.6	25.1 ± 7.2	18.4	17.3[b]	144 ± 29	217 ± 21	180	195
	B	11.5 ± 2.5	21.2 ± 6.2	16.3		178 ± 15	241 ± 45	209	
3.	A	16.7 ± 5.6	16.8 ± 2.2	16.7	17.8[b]	99 ± 8	134 ± 18	116	123
	B	16.1 ± 0.5	21.7 ± 5.8	18.9		114 ± 5	146 ± 9	130	
Mean		17.2[a]	26.1[b]			212	169		

for explanation see Table 2

Table 4. Content of nitrates in radish (means ± standard deviation) from organic and conventional cultivation

Production term/spacing		Nitrates (mg/kg)		Means	
		O	K	(O + K)/2	Σ(A + B)/4
2.	A	971 ± 490	890 ± 532	930	895
	B	999 ± 194	722 ± 133	861	
3.	A	1,075 ± 404	912 ± 115	993	954
	B	899 ± 338	931 ± 350	915	
Mean		986[a]	864[b]		

for explanation see Table 2; frozen samples from the first term of sowing were destroyed by a power outage; different letters represent significant differences at $P = 0.05$ among method of cultivation (columns)

The total monosaccharides content (Table 3) was higher with statistical significance in the conventional production of radish. The highest difference (by 66%) was in the autumn of 2007 (1st term) and with freer spacing.

The lower monosaccharides content in organic cultivation can be explained by the lower intensity of light under the unwoven textile. This was confirmed by Pulgar et al. (2001), when a reduced content of monosaccharides was found in Chinese cabbage covered by unwoven textile compared to Chinese cabbage grown without unwoven textile.

The average content of vitamin C (Table 3) was higher in organic cultivation due to its significantly higher contents in the year 2007 (data not shown). Kalt (2005) explains that the different findings in the content of vitamin C are caused by different climatic conditions during cultivation, temperature and light being the most important factors.

Literature indicates a lower content of nitrates in organic production (Woese et al. 1995; Worthington 1998; Heaton 2001; Tauscher et al. 2003). The results of our study, however, did not confirm this trend (Table 4). In accordance with the results of Malmauret et al. (2002), lower values were found in conventional production. The higher levels of nitrates which were observed in organically cultivated radish can be explained with the faster mineralization of organic material under unwoven textiles, which also results in a higher content of nitrogen in the soil (in comparison to conventional cultivation without unwoven textiles). The EU norm does not state a max. level of nitrates in radish. The now withdrawn national standards did not mention the highest permitted level of nitrates in radish, however, there was a norm (Act. 298/1997 Coll.) for radishes allowing a max. of 1,500 mg/kg. The levels measured in the experiment were below this limit both in conventional as well as in organic cultivation.

The system of cultivation had no significant effect on the content of potassium and sodium (Table 5). Warman and Havard (1998) reported a higher sodium content in an organic fertilization variant compared to mineral fertilization. This trend was not confirmed. Organically grown radish was found to have an insignificantly lower level of sodium. For

Table 5. Content of potassium (K) and sodium (Na) (means ± standard deviation) in radish from organic and conventional cultivation

Production term/spacing		K (g/kg)		Means		Na (mg/kg)		Means	
		O	K	(O + K)/2	Σ(A + B)/4	O	K	(O + K)/2	Σ(A + B)/4
1.	A	4.0 ± 0.4	3.9 ± 0.5	3.9	3.8[a]	153 ± 49	152 ± 45	152	159[a]
	B	3.6 ± 0.8	3.8 ± 0.1	3.7		135 ± 39	196 ± 74	165	
2.	A	3.7 ± 0.1	3.4 ± 0.1	3.5	3.5[a]	163 ± 25	177 ± 45	170	170[a]
	B	3.6 ± 0.1	3.5 ± 0.2	3.5		164 ± 20	177 ± 30	170	
3.	A	3.3 ± 0.4	2.9 ± 0.1	3.1	3.0[b]	70 ± 19	75 ± 24	72	66[b]
	B	3.1 ± 0.3	2.7 ± 0.3	2.9		53 ± 16	65 ± 37	59	
Mean		3.5	3.4			123	140		

for explanation see Table 2; different letters represent significant differences at $P = 0.05$ among the terms of sowing (lines)

Table 6. Content of calcium (Ca) and magnesium (Mg) (means ± standard deviation) in radish from organic and conventional growing

Production term/spacing		Ca (mg/kg)		Means		Mg (mg/kg)		Means	
		O	K	(O + K)/2	Σ(A + B)/4	O	K	(O + K)/2	Σ(A + B)/4
1.	A	246 ± 20	254 ± 57	250	240^{a}	185 ± 12	223 ± 74	204	193^{a}
	B	221 ± 30	240 ± 34	230		165 ± 35	198 ± 27	181	
2.	A	177 ± 19	170 ± 7	174	173^{b}	116 ± 11	124 ± 9	120	122^{bc}
	B	176 ± 5	171 ± 1	173		118 ± 12	132 ± 3	125	
3.	A	128 ± 25	122 ± 9	125	120^{c}	104 ± 19	111 ± 4	107	104^{c}
	B	122 ± 9	107 ± 11	114		99 ± 7	102 ± 8	100	
Mean		178	177			131	148		

for explanation see Table 2; different letters represent significant differences at $P = 0.05$ among terms of sowing (lines)

the contents of potassium and sodium, the term of cultivation had a significant effect, however, the effect of growing system was inconclusive.

Again, for the content of calcium and magnesium, there was no difference between organic and conventional production (Table 6). Rembialkowska (2003) found no difference in the content of Ca, K and Mg between organic and conventionally grown carrots.

The results of sensory evaluation of radish from organic and conventional cultivation are in Table 7. In 2007, the number of better – evaluated descriptors of organic to conventional was in the ratio of 6:5, in 2008 the ratio was 7:4. Appearance, intensity of smell and fragility in these two years were higher evaluated in organic production, while sweetness was higher in conventional production. The largest difference in favour of conventional production concerned the descriptors of sweetness.

Summary

- No higher nutritional value of organically grown radish was confirmed.
- Conventionally grown radish had significantly higher dry matter content, carbohydrates and lower content of nitrates.
- No statistically significant difference was found between organic and conventional production for the content of crude fibre, vitamin C, potassium, calcium, sodium and magnesium.

Table 7. Results of sensory evaluation of radish from organic and conventional cultivation

Descriptors	Autumn 2007		Autumn 2008	
	O	K	O	K
Appearance	13	23	6	15
Colour of flesh	23	13	8	13
Intensity of smell	12	24	10	11
Sweet taste	26	10	11	10
Bitter taste	10	26	11	10
Spicy flavour	13	23	11	10
Undesirable taste	13	23	12	9
Overall taste	22	14	10	11
Fragility	13	23	7	14
Juiciness	21	15	8	13
Overall impression	24	12	8	13
Total	190	206	102	129

for each descriptor the lower number means better evaluation

– Total sensory value was better evaluated in organic production.
– The majority of nutritional characteristics was significantly influenced by the term of cultivation (climatic conditions).

References

Act. 298/1997 Coll. of the Ministry of Health of the Czech Republic setting the requirements on the content of the chemicals in processed food and raw food material, conditions of their usage and information required on the product label. Valid till March 1, 2002.

Benoit F., Ceustermans N., 1992. Hydroculture of culinary herbs. Revue de l' Agriculture, *45*: 1077–1089.

Bognár A., 2002. Vergleichende Untersuchungen über den Gehalt an Nährstoffen, Vitaminen und Nitrat von Blattsalaten (Endivie, Lollo Rosso, Eisberg- und Kopfsalat) aus ökologischem und konventionellem Anbau. Bundesforschungsanstalt für Ernährung (Hrsg.): Jahresbericht 2001. Available at http://www.bfa-ernaehrung.de

Bünnagel G., 1992. Untersuchung der sensorischen Qualität und diskriminan analytische Trennung von biologisch-dynamisch und konventionell angebauten Gemüsen. [Ph.D.Thesis.] Friedrich-Wilhelm-Universität Bonn.

Eckhard G., Reyhaneh E., 2003. Ökologischer Gemüsebau. Handbuch für Beratung und Praxis. 1. Aufl. Mainz, Bioland-Verlag: 352.

Givens I., Baxter S., Nihane A.M., 2008. Health Benefits of Organic Food: Effects of the Environment. Dewey Decimal. Wallingford, CABI Publishing: 333.

Hajšlová J., Schulzová V., 2006. Porovnání produktů ekologického a konvenčního zemědělství. [A Comparison of Organic and Conventional Agriculture.] Prague, UZPI: 23.

Heaton S., 2001. Organic Farming, Food Quality and Human Health. A Review of the Evidence. Bristol, Soil Association: 87.

Javorský P., Krečmer F., Uhnák J., 1987. Chemické rozbory v zemědělských laboratořích, II. [Chemical Analysis in Agricultural Laboratories, II.] České Budějovice, Czech Ministry of Agriculture: 268.

Kalt W., 2005. Effects of production and processing factors on major fruit and vegetable antioxidants. Journal of Food Science, *70*: 1–18.

Kopec K., Horčin V., 1997. Senzorická analýza ovocia a zeleniny. [Sensory Analysis of Fruit and Vegetables.] 1st Ed. Nitra, Universum: 194.

Kvasnička F., 1997. Návod k obsluze izotachoforetického analyzátoru IONOSEP 900.1. [Operating Manual Isotachophoresis Analyzer IONOSEP 900.1.] Ostrava, Recman.

Malmauret L., Parent-Massin D., Hardy J.L., Verger P., 2002. Contaminants in organic and conventional food-stuffs in France. Food Additives and Contaminants, *19*: 524–532.

Pulgar G., Moreno D.A., Villora G., Herrnández J., Castilla N., Romer L., 2001. Production and composition of Chinese cabbage under plastic row covers in southern Spain. Journal of Horticultural Science and Biotechnology, *76*: 608–611.

Tauscher B., Brack G., Flachwsky G., Hening M., Kopke U., Meier-Ploeger A., M., Unzing K., Niggli U., Pabst K., 2003. Bewertung von Lebensmitteln verschiedener Produktionsverfahren. Statusbericht: 38–78.

Rembialkowska E., 2003. Organic farming as a system to provide better vegetable quality. In: Tijskens M., Vollebregt H.M. (eds), Proceedings of the International Conference on Quality in Chains. Acta Horticulturae (ISHS), 604: 473–480.

Švachula V. et al., 1992. Pokusná a demonstrační pracoviště agronomické fakulty VŠZ Praha. [Experimental and demonstration workplace Faculty of Agronomy, University of Agriculture Prague.] Prague, VŠZ Praha: 46.

Warman P.R., Havard K.A., 1998. Yield, vitamin and mineral contents of organically and conventionally grown potatoes and sweet corn. Agriculture, Ecosystems and Environment, *68*: 207–216.

Woese K., Lange D., Boess C., Bögl K. W., 1997. A comparison of organically and conventionally grown foods: Results of a review of the relevant literature. Journal of the Science of Food and Agriculture, *74*: 281–293.

Woese K., Lange D., Boess C., Bögl K.W., 1995. Ökologisch und konventionell erzeugte Lebensmittel im Vergleich - Eine Literaturstudie, Teil I. and II. Berlin, Bundesinstitut für gesundheitlichen Verbraucherschutz und Veterinärmedizin (BgVV): 758.

Worthington V., 1998. Effect of agricultural methods on nutritional quality: A comparison of organic with conventional crops. Alternative Therapies, *4*: 58–69.

Worthington V., 2001. Nutritional quality of organic versus conventional fruits, vegetables and grains. Journal of Alternative and Complementary Medicine, *7*: 161–173.

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