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NUTRIENTS AND CONTAMINANTS CONTENT IN THREE ORGANIC EDIBLE ROSES

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Abstract

This study aims to present the influence of the organic technology applied to three edible English roses on nutrients and contaminants content. Fresh petals from Falstaff (F), Brother Cadfael (B) and Crown Princess Margareta (C) cultivars and three variants of jam using different ingredients were analysed and determined the content of minerals and contaminants. The results showed significant differences between experimental variants regarding nutrients content. Cu was found at low levels, with a maximum of 2.307 mg kg^{-1}, important result for the organic protection scheme. The highest values were of K found in all variants, in the fresh petals 2143.40-2625.89 mg kg^{-1} (C), 2378.77-3103.65 mg kg^{-1} (F) and 2176.13-2903.97 mg kg^{-1} (B) and in the jam variants 538.77-616.045 mg kg^{-1} (C), 544.14-685.22 mg kg^{-1} (F) and 486.02-729.38 mg kg^{-1} (B). Important quantities of Ca and Mg were found in fresh petal variants. All the analysed samples of fresh rose petals and rose petal jam had contaminants traces bellow the standard maximum limits. Important quantities of minerals were found, expressing the positive influence of the applied organic technology.

Key words: *edible rose, minerals and contaminants content, rose petal jam.*

INTRODUCTION

Roses are one of the most present ornamental plants in human life. Together with beauty, elegance, fragrance, they have a specific role in medicine, food and cosmetics industry, requiring special standards.

An organic technology for climbing edible roses was established between the 2015-2017 period and registered at the State Office for Inventions and Trademarks (Butcaru et al., 2018a). Organic technology' influence on plant development and production (Butcaru et al., 2020), on fresh rose petal and rose petal jam biochemical compounds (Butcaru et al., 2019; Butcaru et al., 2018b; Butcaru et al., 2017) were analysed.

Monitoring and analysing the specific amount of contaminants and minerals in the final products, respectively in rose petals were important aspects of organic technology for edible roses.

Potassium, in the plant, stimulates the production of quality flowers and increases resistance to diseases, pests, drought and frost; regulates the water regime in the cell; has a role in the transport and storage of organic reserve substances (Hessayon, 2005; Madjar & Davidescu, 2009). For human health, potassium is needed for the maintenance of total body fluid volume, acid and electrolyte balance, and normal cell function. Reduced potassium consumption has been correlated with hypertension and cardiovascular diseases and appropriate consumption levels could be protective against these conditions (WHO, 2012).

Calcium, in the plant, gives tissues resistance, is involved in fruit ripening, root development, detoxification of the plant from ions and radicals that occur in metabolic processes (Hessayon, 2005; Madjar & Davidescu, 2009). For humans, calcium is an essential nutrient that plays a vital role in neuromuscular function, many enzyme-mediated processes and blood clotting, as well as providing rigidity to the skeleton (WHO & FAO, 2004).

Magnesium is involved in the process of photosynthesis, promotes the absorption and translocation of phosphorus in energy transfer

(Hessayon, 2005; Madjar & Davidescu, 2009). In the human body, 30-40% of the total level of magnesium is found in muscles and soft tissues, 1% is found in extracellular fluid, and the rest in the skeleton (WHO, 2012).
Iron enhances the green color of the leaves; contributes to the plant health. It has a role in the synthesis of auxins, implicitly in the development of roots (Hessayon, 2005; Madjar & Davidescu, 2009). It is important for electron transport in some enzymes and it is associated with enzymes in chlorophyll formation (Lohry, 2007). Regarding human health, iron serves as an oxygen carrier to the tissues, as a transport medium for electrons within cells and as an integrated part of important enzyme systems in various tissues (WHO & FAO, 2004).
Zinc has a protective role for auxins; it is involved in seed formation (Hessayon, 2005; Madjar & Davidescu, 2009). As a plant nutrient, Zn is involved in numerous plant metabolic and physiological processes. Zn can negatively affect plant metabolic reactions both at low (Lohry, 2007) as well as at higher levels (Shadid, 2017). Zinc toxicity can induce a deficiency of other minerals like Mg, Fe or Mn (Tripathi et al., 2015). Zn is an important mineral for human health, one-third population of the world suffering from Zn deficiency (Shadid, 2017) related to poor immune system, poor physical and mental growth (Sharma et al., 2013).
Copper has a specific role in plant metabolism (Hessayon, 2005; Madjar & Davidescu, 2009). In excess is bound to phytochelatins. A deficiency interferes with protein synthesis (Lohry, 2007). In the human body, copper has a role in the immune defense mechanism (WHO, 2012).
In-plant metabolism, most elements interact with each other, for example (Zn-Fe) the metabolic functioning of Fe in plants is connected in a way with the supply of Zn; (Fe-Mn) are positively correlated in their metabolic functions, (Fe-Mo) at a marginally adequate level, Mo enhanced Fe uptake, and at higher levels depressed Fe uptake; (Cu-Mo) - antagonism; (Cu-Zn) - zinc induce a copper deficiency in several crops (Ronen, 2007); higher levels of Ca limit Fe uptake.
For some of the contaminants analysed (Be, V, Co, Ni, As, Sr, Mo, Ag, Cd, Sb, Ba, Ti, Pb, Th, U, Al) the international regulation established the maximum limit (Regulation 1881/2006).
Arsenic has been ranked number one pollutant from the top twenty toxic substances. In the plant, interferes with numerous plant metabolic processes, leading to decreased biomass, affects growth and chlorophyll synthesis, DNA breakage, membrane leakage, enzyme inactivation, affect on RUBISCO. Human exposure to high levels of As via contaminated foods is linked to respiratory diseases, diabetes, reproductive disorders, liver and cardiovascular problems, gastrointestinal, high blood pressure and cancer of skin, liver, bladder, kidney and lungs (Shadid, 2017).
Lead at higher levels can induce several toxic effects in plants. Decreased seed germination, inhibition of chlorophyll synthesis and plant biomass, affect the physiological parameters are some of the effects. For human health, lead (the second toxic substance) can lead to mental impairment in children under 15, affect bones, heart, kidneys, intestine, nervous and reproductive systems (Shadid, 2017).
Cobalt, at low levels, promotes plant growth and possibly can, indirectly, bring biotic stress resistance. Higher levels are toxic, damaging various physiological and biochemical activities. The excess of cobalt induces Fe deficiency. For humans, exposure to cobalt can lead to lung disease, being considered carcinogenic (Shadid, 2017).
In plants, nickel is part of numerous enzymes including ureases, and low levels induce positive effects. But, high levels of nickel lead to toxic effects. It is also recognized as a carcinogen for humans (Shadid, 2017).
This study aims to present the influence of the organic technology applied to three edible climbing English roses cultivated in a specially designed orchard on nutrients and contaminants content.

MATERIALS AND METHODS

The research has been carried out in the Experimental Field of Faculty of Horticulture and in the Research Centre for Studies of Food and Agricultural Products Quality within USAMV Bucharest.
In 2015, an organic rose culture of a total area of 1,350 m^2 with three climbing edible

cultivars: 'Falstaff' (F), 'Brother Cadfael' (B) and 'Crown Princess Margareta' (C) was established and an organic technology was applied. On the row, the soil was mulched with wool and wood chips and for irrigation, a drip system was used. The inter-row was kept grassy through repeated mowing. Different bio-stimulators, fertilizers and plant protection specific strategies were used (Butcaru et al., 2018a).

Three variants of jam were made from each cultivar, using different ingredients like lemon, sea buckthorn and ginger and analyzed. To determine the influence of the applied organic technology on the content of minerals and contaminants in fresh rose petals and petal rose jam (Table 1), specific analyses were made.

The micro and macro elements content from the rose petals and rose petal jam has been determined according to AOAC Official Method 2015.01. The results were reported in mg/100 g and mg kg^{-1} according to European legislation - Regulation (EU) No. 1169/2011.

Sample preparation for ICP-MS analysis 0.250g ± 0.0001 g of samples were weighted with an analytical balance in Teflon recipients, then 8 ml concentrated ultrapure HNO_3 (65%) and 2 ml H_2O_2 30% were added and were subjected to mineralization by microwave digestion (30 min.) with ETHOS UP microwave digestion system, then the clear solutions were transferred quantitatively into the volumetric flasks (50 ml) and made up with Milli-Q ultrapure water (2 repetitions) (Milestone ETHOS UP Digestion Apps, Zovinka & Stock, 2010)

The Agilent Series ICP-MS spectrometer with quadrupole analyzer 7700x and MassHunter Workstation software (Agilent Technologies) was used in the analysis.

The calibration curve was performed with ICP-MS multi-element calibration standard (1000 mg/L of Fe, K, Ca, Na, Mg; 100 mg/L of Sr; 10 mg/L of Ag, Al, As, Ba, Be, Cd, Co, Cr, Cu, Mn, Mo, Ni, Pb, Sb, Se, Tl, V, Zn, Th, U in 5% HNO_3) (Sannac et al., 2017; Pacquette et al., 2015; Liba et al., 2014).

Table 1. Sample codification

Code	Explanation	Code	Explanation	Code	Explanation
15 C	Crown Princess Margareta, control	13F	Falstaff, control	14B	Brother Cadfael, control
1C	Crown Princess Margareta, wood chips mulch	2F	Falstaff, wood chips mulch	3B	Brother Cadfael, wood chips mulch
26 C	Crown Princess Margareta, wool mulch	27F	Falstaff, wool mulch	25B	Brother Cadfael, wool mulch
D1-C-l	Crown Princess Margareta rose petal jam with lemon	D2-F-l	Falstaff rose petal jam with lemon	D3-B-l	Brother Cadfael rose petal jam with lemon
D4-C-g	Crown Princess Margareta rose petal jam with ginger	D5-F-g	Falstaff rose petal jam with ginger	D6-B-g	Brother Cadfael rose petal jam with ginger
D7-C-s	Crown Princess Margareta rose petal jam with sea-buckthorn	D8-F-s	Falstaff rose petal jam with sea-buckthorn	D9-B-s	Brother Cadfael rose petal jam with sea-buckthorn

RESULTS AND DISCUSSIONS

The obtained results reflected the influence of the organic technology applied, especially of the fertilization and protection scheme (Singh et al., 2017). The contaminants were generally below the legal limits (Table 2).

Vanadium ranged between 0.004-0.039 mg kg^{-1} (C), 0.015-0.026 mg kg^{-1} (F), 0.003-0.011 mg kg^{-1} (B) in the fresh petals. The processed ones were below 0.005 mg kg^{-1} except for Falstaff with higher values.

Cobalt ranged between 0.002 - 0.018 mg kg^{-1} (C), 0.004-0.021 mg kg^{-1} (F) and 0.00-0.018 mg kg^{-1} (B) in fresh petals with traces in the processed ones. The wool mulched variants presented zero or low values. Dos Santos et al. (2017) obtained values between 0.001-0.01 mg kg^{-1} for the same species.

At Nickel, all the rose petal jams had 0 values. For the fresh petals, it ranges between 0.420-0.687 mg kg^{-1} (C), 0.149-0.491 mg kg^{-1} (F) and 0.021-0.809 mg kg^{-1} (B). The control has higher values at C and B. Dos Santos et al. (2017) obtained values between 0.04-0.2 mg kg^{-1}.

Arsenic was generally at 0 or very low values (bellow 0.05). For the C were registered 0.026 mg kg^{-1} on the control row and 0.010 mg kg^{-1} on the wool mulched row. Dos Santos et al. (2017) obtained also bellow 0.02 mg kg^{-1} values.

Strontium ranged between 0.28-0.81 mg kg^{-1} (C), 0.22-0.58 mg kg^{-1} (F) and 0.12-0.58 mg kg^{-1} (B) in fresh petals with lower values in the processed ones.

Cadmium in fresh petals was between 0.001-0.004 mg kg^{-1} (C), 0.002-0.006 mg kg^{-1} (F) and 0.001-0.002 mg kg^{-1} (B), with maximum 0.001 mg kg^{-1} in jam, all below 0.2. Dos Santos et al. (2017) registered also values bellow 0.001 mg kg^{-1}.

Barium was between 0.146-0.747 mg kg^{-1} (C), 0.393-0.941 mg kg^{-1} (F) and 0.128-0.499 mg kg^{-1} (B) in fresh petals. Some of the processed variants had higher values than in the fresh petals.

Lead traces were quantified between 0.0-0.404 mg kg^{-1} (C), 0.006-0.079 mg kg^{-1} (F) and 0.0-0.070 mg kg^{-1} (B). Some of the jam variants had higher values (lemon and ginger at F and B). Generally, all of them were below 0.30 mg kg^{-1}.

Aluminium was found only in the control and wood dust fresh petal samples, 5.05-15.55 mg kg^{-1} (C), 14.85-24.28 mg kg^{-1} (F), 0.44-13.17 mg kg^{-1} (B) significant higher on the mulched row. Rose petal jam with sea-buckthorn at Falstaff had a higher value.

Interesting results were also found in mineral content (Table 3).

Chromium was significant higher in the fresh petals, with lower content on the wool mulched variants, 0.038-0.103 mg kg^{-1} (C), 0.0-0.145 mg kg^{-1} (F) and 0.018-0.250 mg kg^{-1} (B). Dos Santos et al. (2017) registered in the rose petal analyzed below 0.02 mg kg^{-1} quantities.

The higher content of iron was found in fresh petals on the control row (at Falstaff similar to wood chips mulch), varying between 9.968-53.846 mg kg^{-1} (C), 10.8-25.003 mg kg^{-1} (F) and 7.147-47.979 mg kg^{-1} (B). The jam variants had lower values. Rop et al. (2012) obtained in fresh petals of *Rosa odorata* 3.55 mg kg^{-1}. Dos Santos et al. (2017) presented values between 5.0-7.24 mg kg^{-1}. In a rose jam, Albuquerque et al. (2013) obtained values bellow 0.02 mg kg^{-1}.

Copper had similar values in the three rose varieties with a maximum of 2.307 mg kg^{-1} at Falstaff (control). The jam variants had significantly lower values. Rap et al. (2012) obtained 2.28 mg kg^{-1} and Dos Santos et al. (2017), 1.08-1.67 mg kg^{-1}. In a rose jam, values bellow 0.06 were obtained by Albuquerque et al. (2013).

Table 2. Influence of the applied organic technology on the contaminants content (mg/kg) in fresh petals and rose petal jam

Sample	V	Co	Ni	As	Sr	Cd	Ba	Pb	Al
15C	0.023 ±0.002	0.017 ±0.000	0.687 ±0.006	0.026 ±0.003	0.807 ±0.012	0.004 ±0.002	0.747 ±0.002	0.404 ±0.009	5.046 ±0.229
1C	0.004 ±0.001	0.018 ±0.000	0.492 ±0.015	0.000 ±0.000	0.761 ±0.000	0.001 ±0.002	0.146 ±0.003	0.000 ±0.000	15.551 ±0.093
26C	0.039 ±0.004	0.002 ±0.001	0.420 ±0.024	0.010 ±0.005	0.279 ±0.003	0.001 ±0.002	0.283 ±0.000	0.036 ±0.008	0.000 ±0.000
D1-C-l	0.001 ±0.000	0.000 ±0.000	0.000 ±0.000	0.000 ±0.000	0.109 ±0.005	0.001 ±0.000	0.326 ±0.013	0.008 ±0.002	0.000 ±0.000
D4-C-g	0.003 ±0.000	0.000 ±0.000	0.000 ±0.000	0.000 ±0.000	0.081 ±0.002	0.000 ±0.000	0.122 ±0.005	0.000 ±0.000	0.000 ±0.000
D7-C-s	0.005 ±0.001	0.000 ±0.000	0.000 ±0.000	0.000 ±0.000	0.084 ±0.000	0.001 ±0.000	0.063 ±0.005	0.000 ±0.000	0.464 ±0.656
13F	0.019 ±0.002	0.004 ±0.002	0.367 ±0.024	0.002 ±0.003	0.218 ±0.008	0.002 ±0.000	0.605 ±0.014	0.079 ±0.003	14.850 ±0.669
2F	0.015 ±0.001	0.021 ±0.000	0.491 ±0.022	0.000 ±0.000	0.577 ±0.002	0.006 ±0.002	0.393 ±0.008	0.007 ±0.003	24.284 ±0.337
27F	0.026 ±0.001	0.005 ±0.001	0.149 ±0.001	0.006 ±0.005	0.525 ±0.005	0.004 ±0.001	0.941 ±0.030	0.006 ±0.001	0.000 ±0.000
D2-F-l	0.005 ±0.001	0.000 ±0.000	0.000 ±0.000	0.000 ±0.000	0.206 ±0.000	0.000 ±0.000	0.396 ±0.010	0.212 ±0.002	0.000 ±0.000
D5-F-g	0.011 ±0.001	0.002 ±0.000	0.000 ±0.000	0.004 ±0.000	0.317 ±0.003	0.001 ±0.001	0.525 ±0.016	0.068 ±0.001	0.000 ±0.000
D8-F-s	0.009 ±0.000	0.004 ±0.000	0.000 ±0.000	0.001 ±0.001	0.114 ±0.002	0.000 ±0.000	0.051 ±0.002	0.000 ±0.000	34.530 ±0.889
14B	0.009 ±0.001	0.007 ±0.001	0.809 ±0.035	0.003 ±0.004	0.581 ±0.009	0.001 ±0.001	0.499 ±0.001	0.070 ±0.002	0.441 ±0.624
3B	0.011 ±0.001	0.018 ±0.000	0.021 ±0.011	0.006 ±0.004	0.252 ±0.009	0.001 ±0.000	0.128 ±0.010	0.022 ±0.005	13.167 ±2.022
25B	0.003 ±0.001	0.000 ±0.000	0.278 ±0.028	0.000 ±0.000	0.117 ±0.000	0.002 ±0.002	0.184 ±0.002	0.000 ±0.000	0.000 ±0.000
D3-B-l	0.002 ±0.000	0.000 ±0.000	0.000 ±0.000	0.000 ±0.000	0.025 ±0.000	0.001 ±0.000	0.226 ±0.011	0.091 ±0.001	0.000 ±0.000
D6-B-g	0.003 ±0.000	0.006 ±0.001	0.000 ±0.000	0.000 ±0.000	0.134 ±0.003	0.001 ±0.001	0.782 ±0.077	0.084 ±0.002	0.000 ±0.000
D9-B-s	0.004 ±0.001	0.000 ±0.000	0.000 ±0.000	0.000 ±0.000	0.000 ±0.000	0.001 ±0.000	0.000 ±0.000	0.000 ±0.000	0.000 ±0.000

Table 3. Influence of the applied organic technology on the minerals content (mg/kg) in fresh petals and rose petal jam

Sample	Cr	Fe	Cu	Zn	Se	Na	Mg	K	Ca
15C	0.08 ±0.01	53.85 ±2.57	1.91 ±0.00	9.19 ±0.04	0.04 ±0.05	45.62 ±1.12	294.00 ±0.09	2143.40 ±1.08	430.21 ±4.13
1C	0.10 ±0.01	16.97 ±3.47	1.38 ±0.00	39.52 ±0.10	0.16 ±0.23	12.56 ±0.11	330.66 ±0.55	2369.02 ±9.56	1252.31 ±4.34
26C	0.04 ±0.01	9.97 ±1.25	1.50 ±0.02	2.50 ±0.03	0.00 ±0.00	0.00 ±0.00	324.27 ±1.94	2625.89 ±12.26	119.04 ±3.30
D1-C-l	0.09 ±0.01	8.23 ±2.08	0.16 ±0.00	0.59 ±0.06	0.00 ±0.00	13.68 ±3.81	51.49 ±1.23	538.77 ±12.96	226.50 ±8.44
D4-C-g	0.00 ±0.00	2.54 ±0.46	0.14 ±0.01	0.00 ±0.00	0.00 ±0.00	24.62 ±1.27	63.43 ±0.69	616.05 ±5.61	0.00 ±0.00
D7-C-s	0.01 ±0.01	0.90 ±1.21	0.16 ±0.00	0.27 ±0.07	0.00 ±0.00	0.32 ±0.45	49.72 ±0.74	560.25 ±3.24	68.56 ±3.03
13F	0.14 ±0.01	24.71 ±1.06	1.44 ±0.00	17.26 ±0.18	0.04 ±0.03	21.89 ±1.48	288.49 ±2.51	2378.77 ±23.36	326.22 ±7.14
2F	0.12 ±0.00	25.00 ±0.72	2.31 ±0.01	26.73 ±0.08	0.27 ±0.18	23.14 ±0.72	382.03 ±1.81	3103.65 ±17.96	676.88 ±3.30
27F	0.00 ±0.00	10.80 ±1.15	1.24 ±0.01	16.00 ±0.12	0.00 ±0.00	6.20 ±2.63	312.45 ±5.17	2608.78 ±35.45	316.60 ±8.68
D2-F-l	0.00 ±0.00	5.01 ±1.44	0.27 ±0.01	1.22 ±0.05	0.00 ±0.00	7.03 ±1.29	56.65 ±2.38	544.14 ±5.25	62.75 ±6.38
D5-F-g	0.00 ±0.00	9.12 ±1.11	0.23 ±0.00	0.00 ±0.00	0.00 ±0.00	45.64 ±2.44	75.38 ±0.71	685.22 ±3.41	148.38 ±2.97
D8-F-s	0.11 ±0.00	4.73 ±1.03	0.18 ±0.01	0.08 ±0.00	0.00 ±0.00	0.00 ±0.00	57.87 ±1.13	599.98 ±5.86	43.82 ±3.61
14B	0.25 ±0.01	47.98 ±1.83	1.81 ±0.01	12.00 ±0.12	0.03 ±0.04	79.48 ±2.30	247.94 ±2.77	2176.13 ±18.48	299.92 ±7.06
3B	0.10 ±0.02	17.95 ±2.53	1.62 ±0.04	16.14 ±0.31	0.28 ±0.37	15.76 ±4.16	305.01 ±7.35	2863.82 ±58.92	370.88 ±10.46
25B	0.02 ±0.00	7.15 ±3.27	1.33 ±0.00	5.25 ±0.00	0.00 ±0.00	0.55 ±0.53	300.35 ±0.44	2903.97 ±7.68	132.72 ±0.91
D3-B-l	0.05 ±0.01	4.31 ±0.11	0.13 ±0.00	0.00 ±0.00	0.00 ±0.00	110.03 ±0.20	41.97 ±0.06	486.02 ±0.79	0.00 ±0.00
D6-B-g	0.00 ±0.00	4.89 ±0.76	0.22 ±0.00	0.44 ±0.03	0.00 ±0.00	16.67 ±1.50	67.78 ±0.77	729.38 ±8.75	42.77 ±1.76
D9-B-s	0.00 ±0.00	0.00 ±0.00	0.12 ±0.00	0.05 ±0.03	0.00 ±0.00	0.00 ±0.00	45.70 ±0.38	581.53 ±5.05	0.00 ±0.00

Regarding the Zinc content, the highest values were registered in the control fresh petals and the lowest on the wool mulched variants, varying between 2.499-39.525 mg kg^{-1} (C), 16.004-26.725 mg kg^{-1} (F) and 5.249-16.141 mg kg^{-1} (B). The jam variants had much lower values. Rap et al. (2012) obtained 4.55 mg kg^{-1} and Dos Santos et al. (2017), 2.34-3.03 mg kg^{-1}. In a rose jam, values bellow 0.2 mg were mentioned by Albuquerque et al. (2013).

Selenium was found only in fresh petal, in the control (higher) and the wood chips mulched variants, 0.038-0.164 mg kg^{-1} (C), 0.036-0.266 mg kg^{-1} (F) and 0.027-0.275 mg kg^{-1} (B). In a rose jam, values between 5.0- 16 µg were reported by Albuquerque et al. (2013).

Significant quantities of Na were found in the rose petal jams, especially in D5-F-g and D3-B-l. In the fresh petals, all the wool mulched variants had significantly lower values. Rap et al. (2012) obtained 76.61 mg kg^{-1}. In a rose jam, values bellow 7.0 mg were obtained by Albuquerque et al. (2013).

Significant quantities of Magnesium were found in the fresh petals, similar for control and wool mulched rows, 294.0-330.656 mg kg^{-1} (C), 288.493-382.029 mg kg^{-1} (F) and 247.94-305.013 mg kg^{-1} (B). The jam variants had lower values, between 41.968-75.375 mg kg^{-1}. Rap et al. (2012) obtained 141.83 mg kg^{-1} and Dos Santos et al. (2017), 277-326 mg kg^{-1}. In a rose jam, values between 3.0-10 mg were obtained by Albuquerque et al. (2013).

Significant quantities of potassium were found in all variants, in the fresh petals 2143.40-2625.89 mg kg^{-1} (C), 2378.77-3103.65 mg kg^{-1} (F) and 2176.13-2903.97 mg kg^{-1} (B) and in the jam variants 538.77-616.045 mg kg^{-1} (C), 544.14-685.22 mg kg^{-1} (F) and 486.02-729.38 mg kg^{-1} (B). The wood chips variants, for the fresh petals and the lemon variants, for rose petal jam variants had lower values. Rap et al. (2012) obtained 1969.11 mg kg^{-1}. In a rose jam, values between 8.0-25 mg were obtained by Albuquerque et al. (2013).

Important quantities of calcium were found in fresh petal variants, 119.04-1252.31 mg kg^{-1} (C), 316.60-676.88 mg kg^{-1} (F) and 132.72-370.88 mg kg^{-1} (B). The highest values were in the control followed by wood chips variants. Rap et al. (2012) obtained 275.15 mg kg^{-1} and Dos Santos et al. (2017), 132- 301 mg kg^{-1}. Some of the jam variants presented 0 values. Albuquerque et al. (2013) reported values bellow 7.0 mg in rose petal jam.

	Co	Ni	As	Sr	Cd	Ba	Pb	Al	Cr	Fe	Cu	Zn	Se	Na	Mg	K	Ca
V	0.22	0.45	0.62	0.43	0.47	0.43	0.22	0.07	0.10	0.37	0.57	0.19	0.06	(-0.14)	0.61	0.56	0.12
Co		0.54	0.37	0.75	0.59	0.16	0.20	0.54	0.45	0.60	0.73	0.79	0.86	0.04	0.67	0.62	0.79
Ni			0.49	0.79	0.55	0.31	0.34	0.14	0.68	0.87	0.84	0.57	0.27	0.26	0.74	0.68	0.57
As				0.56	0.41	0.42	0.75	(-0.07)	0.10	0.66	0.47	0.04	0.02	0.13	0.39	0.33	0.13
Sr					0.65	0.47	0.40	0.22	0.45	0.78	0.75	0.73	0.43	0.16	0.70	0.60	0.79
Cd						0.52	0.26	0.28	0.18	0.53	0.71	0.50	0.41	0.02	0.66	0.62	0.43
Ba							0.48	(-0.22)	0.04	0.45	0.30	0.13	(-0.14)	0.19	0.28	0.24	0.09
Pb								(-0.16)	0.05	0.58	0.19	(-0.10)	(-0.13)	0.33	0.04	(-0.03)	(-0.01)
Al									0.47	0.15	0.29	0.46	0.54	(-0.19)	0.28	0.25	0.41
Cr										0.72	0.57	0.47	0.38	0.37	0.42	0.40	0.43
Fe											0.76	0.44	0.30	0.41	0.58	0.53	0.45
Cu												0.71	0.61	0.06	0.95	0.94	0.62
Zn													0.73	(-0.04)	0.77	0.71	0.95
Se														(-0.04)	0.59	0.59	0.67
Na															(-0.09)	(-0.11)	(-0.03)
Mg																0.99	0.67
K																	0.58

Figure 1. Pearson Correlation matrix

Strong correlations were observed between elements Co-Se, Ni-Fe, Ni-Cu, Cu-Mg, Cu-K, Zn-Ca, Mg-K. Some of the correlations are similar to De Saedeleer et al. (2010) and Dobrin et al. (2018).

CONCLUSIONS

All the analyzed samples of fresh rose petals and rose petal jam had contaminants traces bellow the standard maximum limits. Important quantities of minerals were found, expressing the positive influence of the applied organic technology. Very strong correlations observed between minerals should be confirmed through the following researches.

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