THE INFLUENCE OF DIFERENT FERTILIZERS ON THE CHEMICAL COMPOSITION OF CARROTS

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Abstract. *Agriculture is one of the most important branches of the economy and its main purpose is to provide sufficient food for the approximately 8 billion individuals of the planet. Over the last decades public debate has moved on to the quality of agricultural products and the discussion about quantity has fallen into a secondary plan. It was already established that an agricultural production considered to be qualitative can be achieved by applying correct and balanced crop technologies The fertilization process is an important step in the culture technology and with visible effects on the quality of production. The purpose of this study is to determine the influence of various fertilizers on the chemical composition of carrot roots. Depending on the type of fertilizer applied we can observe the evolution of chemical elements from the carrot roots.The duration of the study will be three years and we will take in consideration the soil and climatic conditions in the Veresti village, Suceava county, where the experience is located. The aim of this study is to develop an innovative technology that will increase the production without neglecting the qualitative side. The benefits of carrot consumption are many and very well known. The lately increase in the number of cancer patients led to a large amount of studies in order to find specific treatment. Latest studies have demonstrated the beneficial effect of vitamin A in treatments for different types of cancer. In these studies, a strong positive effect was observed after including carrots in the diet of cancer patients. Carrots are very rich in vitamin A, a medium-sized root contains 157% of the recommended daily vitamin A dose (7,836 international units). The study is focused on the influence of two types of fertilizers, NPK and organic fertilizer (bovine waste), on the chemical composition of carrots. It's intended to provide information and solutions for the application of an innovative culture technology with an indirect influence on the health of individuals.*

Key words: *fertilizers, chemical composition, benefits, quality, production.*

INTRODUCTION

Carrot is known under the scientific name *Daucus carota* subsp. *sativus*. This crop is part of the Apiaceae botanical family, originated in the south-western areas of Asia (Afghanistan and Pakistan) and then spread to Europe. It has been cultivated for more than 2,000 years for the special taste it gives to culinary preparations and also for its curative effects.

Carrots are considered to be the elixir of health because of the roots which contain nutrients with beneficial effects on the human body. In the last decades various studies have been made in order to demonstrate the effect of vitamin A on many types of cancers such as of colon and digestive tract. Carrot roots contain between 5 and 24 g β-carotene, which is a precursor of vitamin A. There are many known therapeutic and beneficial effects of carrot consumption such as: diuretic, antihemorrhagic, analgesic and cicatrisant, reduces gastrointestinal inflammation, acts against hyperacid gastritis, in gastroduodenal ulcers, in the prevention of heart diseases, vision improvement, infections, cancer, anti-aging treatments, on the digestive system, chronic bronchitis and asthma.

In the following decades the carrot crop could gain a big interest given the recorded effects after being introduced into the diet of cancer and healthy patients. Thus, focus should be directed on improving the technology of carrot cultivation in order to increase the value of chemical composition and productivity. In the present study methods used, results obtainedand conclusions regarding the research will be presented.

The main objectives of the paper were: analyzing the content of vitamin A in carrot roots, known to have properties against different types of cancer, determination of the efficiency of different fertilizers on the chemical composition of carrot roots; applying an innovative cultivation technology.

MATERIAL AND METHODS

In the first stage of the study, the location of the experiment and the experimental plot were established. From the perimeter of the plot soil samples were taken to identify the physical and chemical properties of the soil. Carrots have deep roots therefore the samples were taken from different depths (0 - 20 cm, 0 - 40 cm and 40 - 60).

The methods of analysis and interpretation of the results are in accordance with the methodology and the working technique indicated by the scientific literature. Among these methods we mention: pH in H2O - potentiometric method in soil - liquid suspension 1: 2.5; Humus (%) - Walkley-Blak method; N total (%) - Kjeldahl method. Nitrogen index, - IN = HUM x VAh / 100; P mobile (ppm) - in solution with ammonium lactate acetate at pH = 3.75 by colorimetric method; K mobile (ppm) - in ammonium lactate acetate solution at pH = 3.75 by flame-throwing method, Bases cations - Scheibler method (me / 100 g soil), Total cation exchange capacity, Degree of saturation in bases.

The experimental field is located in Vereşti village, Suceava county, the Siret meadow. Temperature and precipitation in this area are specific to the continental temperate climate, with annual average values of 7.8 °C and 550 - 600 mm. The experimental plot has 5.7 a and the number of experimental variants is 12. The method used to locate the experience is that of the Latin rectangle, developed in 1952 by Mudra. By applying this method, the study of a large number of variants without the increasing of the number of repetitions was achieved. Experimental variants were placed in three repetitions, summing up to 32 experimental variants. In the first repetition the variants were arranged in ascending order and in the other two repetition they were placed randomized. The study will take place for a period of 3 years (2016, 2017 and 2018). The results presented are those from the first year of study. Two types of fertilizers were taken into consideration, NPK and bovine waste.

Table 1.

Scheme of location in the experience

R III	V3	V9	V7	V1	V8	V11	V5	V12	V4	V2	V6	V11
R II	V2	V8	V1	V3	V11	V9	V10	V7	V12	V6	V4	V5
R I	V1 NPK 15:15:15	V2 Manure of Cattle	V3 NPK + Manure	V4 NPK 15:15:15	V5 Manure of Cattle	V6 NPK + Manure	V7 NPK 15:15:15	V8 Manure of Cattle	V9 NPK + Manure	V10 NPK 15:15:15	V11 Manure of Cattle	V12 NPK + Manure

(Reference: Original)

The hybrid cultivated in the experiance was Laguna F1 and the period of cultivation was April 3, 2016 and 2017. Laguna F1 is a Nantes hybrid with a smooth, cylindrical root, uniform and with a very fast growth, pleasant color (intense orange) and is commercially agreeable.

During the vegetation period various numerical measurements were taken in order to observe the degree of crop development. The interaction between factors was analyzed by satatistic method such as: mean, variance (s2) and standard deviation of mean.

To determinate the composition of carrot roots the following methods have been used: STAS 12586-87 for determination of organic substance and humidity in carrot roots; SR ISO 7150-1: 2001 for the determination of ammoniacal nitrogen (NNH4 +) ; SR EN ISO 10304-1: 2009 for the determination of nitrites (NO2) and nitrates (NO3) ; ISO 13878: 1998 for Kjeldahl nitrogen (proteins) ; SR EN ISO 11885: 2009 for the amount of potassium, sodium, calcium, total phosphorus and magnesium.

For determination of carotenoids from carrot roots two methods have been used, a spectrophotometric method and high performance liquid chromatography (HPLC). Two samples were analyzed, the first sample was taken from variants where NPK fertilizer was applied and the second where bovine waste was applied.

HPLC conditions: Shimadzu LC20 AT detector SPD-M20A, Supelco Discovery C18 column (250 x 4.6 mm), 5 μm. The mobile phase was a mixture of two solvents: acetonitrile: water (9: 1, v / v) with 0.25% triethylamine (solvent A) and ethyl acetate with 0.25% triethylamine (solvent B). The flow rate used was 1 ml / min. Chromatograms were monitored at 450 nm. The gradient program started from 20% B to 50% B from minute 0 to 4th minute. Then from 4th minute to 12th minute the percentage of B increased from 50% to 65%. The program proceeded isocratic (minutes 12-60) then the concentration of solvent B decreased from 65% to 20% in two minutes (from 60 minutes to 62 minutes).

RESULTS AND DISCUSSIONS

Carrot crop is sensitive to soil, soils with high permeability, deep and with a humus content between 4-5% and neutral pH are preffered. Cultivation of carrots in a poorly ventilated and poorly fertilized soil has negative effects on quality and production explained by the fact that branching and sharpening occurs in the top of the root.

Thus, before placing the field experience, soil samples were taken. Soil analysis was performed from samples taken from different depths (0-20 cm, 20-40 cm and 40-60 cm). Samples were collected on the 6th of April 2016, with the help of the paddle and were taken from 5 different points on each diagonal of the plot.

Soil analysis in terms of thecontent in humus, phosphorus, potassium, nitrogen and carbonates, pH-determination and granulometric analysis were performed in the Office of Pedological and Agrochemical Studies from Cluj. The results of the laboratory results regarding the physical and chemical characteristics of the soil are presented in Table 2.

Table 2.

Physical and chemical soil indexes (2016)

Depth (cm)	**0-20**	**20-40**	**40-60**
Coarse sand%	0,10	0,09	0,047
Fine sand%	46,67	36,03	35,62
Dust I%	10,40	18,03	22,79
Dust II%	14,92	13,49	8,84
Clay	27,91	32,36	32,70
Interpretation of texture	Clay-sand	Clay	Clay
Ph	7,68	7,80	7,92
Interpretation	Slightly alkaline	Slightly alkaline	Slightly alkaline
Carbonates CaCO3%	1,5	1,8	1,80
Interpretation	Slightly carbonated	Slightly carbonated	Slightly carbonated
Humus%	1,74	2,39	1,38
Interpretation	Low	Middle	Low
N total%	0,174	0,219	0,187
Interpretation	Moderate	Good	Moderate
P205 mobile ppm	40	29	30
Interpretation	Good	Moderate	Moderate
K20 mobile	140	116	110
Interpretation	Good	Moderate	Moderate

(Reference:Original)

Based on the results obtained, the soil has a clay-sandy texture on the surface and descending deeply the texture is clay. The clay-sandy texture is present in the arable surface (0-20 cm) and allowed a good development for roots without branching. As it can be seen in *Table 2,* the pH of the soil is slightly alkaline. On the depth of 0-20 cm there is a moderate supply on total nitrogen and good in P and K, and on a depth of 20-40 cm the soil has a good supply in N and moderate in K and P and if we go lower at 40 - 60 cm we have a moderate supply in these three elements.

The content in organic matter is low on the depths of 0-20 cm and 40-60 cm, and at a depth of 20-40 cm is moderate. This type of soil is not the ideal soil for the carrot crop, but satisfactory results have been achieved at the end of the vegetation cycle.

Fertilization is a very important step in plant culture technology because it has an influence on production and composition. Fertilization for carrot cultivation is done phasially, taking into account the specific consumption of the plant, the nutrient content of the soil and the amount of manure applied. In order to achieve a fair and efficient fertilization it is essential to take into account the above mentioned elements.

The average specific nutrient consumption per tonne of plant product is 3 kg N, 1.5 kg P2O5 s.a, 5 kg K2O s.a. and 5.5 kg CaO s.a. The recommended dose of recommended manure for carrot crop is 30-40 t/ha and is applied to the pre-culture.

On the experimental plot 35 t/ha of bovine waste was applied when plowing was performed. Although in the specialized literature it is recommended to apply the manure to the pre-culture, the manure was applied in the cultivation year in order to observe the changes made on the commercial aspect and also on the composition. Results of the laboratory analyzes for the two samples of carrot roots NPK 15:15:15 and respectively bovine manure are presented in *Table 3.*

Table 3.

Total carotenoid content of carrot roots

Pigment	Retention time (Min)	**Manure**		**NPK 15:15:15**	
		Percentage of the total	mg/100g	Percentage of the total	mg/100g
Lutein	9.03	2.79	0.34	3.81	0.53
α-carotene	20.38	32.63	3.98	34.76	4.85
β-carotene	20.70	61.10	7.45	57.48	8.02
Other carotenoids	-	3.48	0.42	3.95	0.55
Total			**12,20 mg/100g**		**13,95 mg/100g**

(Reference:Original)

The total amount of carotenoids is 12,20 mg/100 g for the sample fertilized with bovine manure and 13,95 mg/100 g in the case of the sample fertilized with NPK 15:15:15. We can observe a significant difference in the carotenoid content identified in the carrot sample fertilized with NPP 15:15:15 in comparison with the sample fertilized with bovine manures.

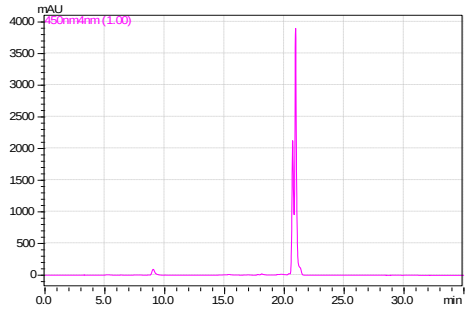

Fig. 1 HPLC chromatogram of total carotenoids carrots fertilized with bovine manure

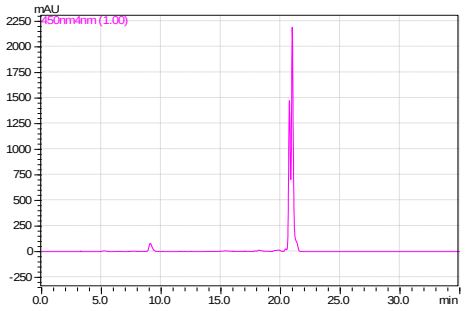

Fig. 2 HPLC chromatogram of total from carotenoids from carrots fertilized with NPK

Each nutrient has an essential role in the proper of the physiological processes in the plant. As it can be see in *Table 4*, the chemical elements accumulated in different quantities in the studied samples.

Table 4.

Results of laboratory analysis for carrot samples

Nr.	Name of determination	Unit	Sample	
			NPK	Manure
1	Humidity (dry substance)	%	89,2 (10,8)	89,7 (10,3)
2	Nitrogen Kjeldahl	%	0,991	0.091
3	Potassium (K)	mg/kg	13400	9330
4	Total Phoshorus (Pr)	mg/kg	2635	3115
5	Calcium (Ca)	mg/kg	4220	3860
6	Sodium (Na)	mg/kg	11600	13000
7	Magnesium (Mg)	mg/kg	2300	1860
8	The organic substance (LOI)	%	92,0	92,0

9	Ammoniacal Nitrogen	%	9	3,5
10	Nitrites ($NO_{2)}$	g/kg	SLQ (< 0,5)	SLQ (< 0,5)
11	Nitrates ($NO_{3)}$	g/kg	SLQ (< 0,2)	SLQ (< 0,5)

(Reference:Original)

It can be observed that the sample taken from NPK 15:15:15 variants is richer in nitrogen, potassium, calcium, magnesium, and the ammoniacal nitrogen content is almost three times higher than in thesample fertilized with cattle manure.

The sample taken from variants fertilized with cattle manure is richer in phosphorus and sodium. Carrot is a succulent root that quickly absorbs nitrates and nitrates from the soil. The level of nitrites and nitrates in the two carrot samples was within the permissible limits.

CONCLUSIONS

Carrots are one of the most consumed vegetables being known for their beneficial effects on human health. Many studies have been made on this particular vegetable and the results led towards promoting carrot as a true source of health. Positive effects of carrot consumption have been observed in the case of eye related diseases, digestive system, immune system, urinary system and epidermal diseases such as burns or cuts.

Carrots have also many other benefits such as antianemic, curative, diuretic, remineralizing and sedative effects. Thus, the increase in productivity and in the compositional quality of carrot roots can be achieved through the efficient use of innovative fertilizers. Given the role of different compounds in the treatment of cancer, the evolution of the chemical composition was monitored after the application of two types of fertilizers (NPP 15:15:15 and manure from bovine farms). As it could be seen, the sample from variants fertilized with NPK 15:15:15 had a higher content in carotenoidstherefore we can state that the type of fertilizer applied can have acrucial influence on carrot composition.

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