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STATISTICAL ANALYSIS OF pH, ASCORBIC ACID AND SOME MINERALS OF DIFFERENT TOMATOES ASSORTIMENT

Despina-Maria Bordean, I. Gergen, I. Gogoaşă, Diana Moigrădean
Banat's University of Agricultural Sciences and Veterinary Medicine, Timişoara, Faculty of Food Processing Technology, 119 Calea Aradului, 300645 Timisoara, Romania

Abstract

In this paper we determined and compared the following physic-chemical parameters: pH, acidity, ascorbic acid, and minerals such as Na, K, Ca, Mg, Fe, Cu, Zn and Mn, in samples belonging to different types of tomatoes, cultivated in summer – autumn period. Besides, statistical techniques of multivariate analysis were applied in order to differentiate the differences of summer-autumn tomatoes assortments. The mean values obtained in the different groups were compared by PCA and t-test, assuming that there were significant differences between mean values when statistical comparison gave $p<0.05$. By PCA analysis we observe that iron can be used as a parameter to identify differences between tomatoes assortments and by Tree Diagram potassium.
Keywords: *tomatoes, pH, ascorbic acid, statistical analysis*

Introduction

Fruits and vegetables contain significant amounts of biologically active components that can impart health benefits beyond basic nutrition (Oomah, 2000). Tomatoes constitute an excellent food presenting in their composition a series of elements very appropriate to detoxify the organism and to prevent the appearance of many illnesses like: lycopene, with similar properties to the betacarotenes having anticancerous properties, glutation, vitamin C and vitamin A. It is also very rich in potassium, a mineral that intervenes in the regulation of the corporal liquids as well as in the good state of the nerves, the heart and the muscles. Together with the calcium, very abundant also in the

tomato, it intervenes in the formation of the bones (www.botanical-online.com).

Tomatoes belong to the genus Lycopersicon, which is in the same family, Solanaceae, as potatoes. The resemblance betwixt leaves and flowers of potato and tomato plants seems to validate this taxonomic grouping (Cox, 2000).

Experimental

Tomato sampling and sample preparation: The samples collected from summer - autumn tomatoes assortments. All the samples were cultivated in Banat Region of Romania. Each sample of tomato was constituted by 1 kg. Two tomatoes of each sample were utilized to measure several physic-chemical parameters. Firstly, the tomatoes were cleaned and weighed. Then, a piece of tissue (≈ 2.5 g of weight) of each tomato was cut, and the two pieces corresponding to each sample, were introduced in an Erlenmeyer with 50 ml buffer (1g/L oxalic acid + 4g/L anhydrous sodium acetate) in order to determine ascorbic acid concentration. The rest of those tomatoes were mixed with a Turmix to a homogeneous puree. From this puree several sub-samples were successively weighed in duplicate to measure pH (3 g puree), (Marcos, 2004), and minerals (1 g).

Analytical determinations: The following parameters were determined: pH, ascorbic acid and minerals such as Na, K, Ca, Mg, Fe, Cu, Zn and Mn. The analytical methods used were AOAC method for ascorbic acid or similar. All the methods were assayed and optimized for these samples.

Metal content was determined using a SAA- atomic absorption spectrometry equipped with a D2 lamp background correction system. Determinations were carried out in triplicate. Between 1 and 1.1 g of dried tomato sample were weighed into digestion tubes and 10 ml of HNO_3 Pure Reagent (Merck) added. The mixture was heated into a digestion block in the following sequence: 80°C/20 min, 120°C/20 min, 160°C/60 and 180°C/30 min. Alkaline metals (Na and K) were determined by atomic emission spectrometry and the rest of minerals (Ca, Mg, Fe, Cu, Zn and Mn) by atomic absorption spectrometry with flame air acetylene using adequate conditions for each mineral.

Ascorbic acid was extracted using a buffer (1g/L oxalic acid + 4g/L anhydrous sodium acetate) and titrated against solution using 2,6 Diclorphenolindophenol Natrium (Loba Chemie Wien- Fischamed) 1μM solution till we observe a light pink colour.

The pH was determined by potentiometric measurement made at 20ºC with a METTLER DELTA 340 pH-meter equipped with a combined glass electrode (AOAC, 1990).

Statistics: All statistical analysis have been performed by Statistica 6 and MVSP version 3.1 (demo version), software's for Windows. Mathematically, Principal Components Analysis, PCA consists of an eigenanalysis of a covariance or correlation matrix calculated on the original measurement data. Graphically, it can be described as a rotation of a swarm of data points in multidimensional space so that the longest axis (the axis with the greatest variance) is the first PCA axis, the second longest axis perpendicular to the first is the second PCA axis, and so forth. Thus these first few PCA axes represent the greatest amount of variation in the data set. The correlation matrix is used if standardization is desired. In PCA the eigenvalues equal the variance accounted for by each PCA axis. The eigenvalue for the first axis will be the largest, the second the second largest, and so on. The percentage of the total variance of each axis will also be calculated. Because K variables and ascorbic acid measurements have larger values than the other analysed values we need to transform data to square roots.

Results and Discussions

Table1 shows the results of the analyzed parameters differentiating the tomatoes considered. Large differences were not observed for pH and ascorbic acid content, but some differences could be observed regarding to mineral content.

After applying t-test for independent samples we observe that the variables all significant, only Fe versus pH is not significant, and as t–test for dependent samples we make same observation, as significant we consider only all values with $p<0.05$, the obtained values are presented in table 2.

Table 1. Mineral content and physic-chemical properties of tomatoes samples

Na [ppm]	K [ppm]	Ca [ppm]	Mg [ppm]	Fe [ppm]	Mn [ppm]	Zn [ppm]	Cu [ppm]	pH	Ascorbic acid [mg%]
55.71	2290	19.32	171.9	6.892	0.614	1.369	1.742	4.14	293
64.83	2262	26.46	216.3	2.977	0.489	1.447	2.860	4.35	312
62.93	2316	21.74	303.7	1.024	0.417	0.848	0.567	4.00	332
62.37	2333	19.19	320.4	27.76	0.493	0.886	0.886	4.11	298
42.39	2073	29.32	258.6	2.456	0.550	1.379	0.899	4.20	311
83.67	2256	19.06	304.8	2.406	0.507	0.978	3.419	4.03	345
63.13	2266	16.11	265.6	9.673	0.391	0.942	0.097	4.10	289

It can be observed a very high content of potassium that is in accordance with all literature studies.

Table 2. t-test analysis for independent samples

Variables	Mean	Mean	t-value	p	Std.Dev.	F-ratio	p
Na vs. pH	62.15	4.133	12.5053	0.000000	0.116	11084.2	0.000000
Na vs. AA*	62.15	311.4	-27.3954	0.000000	20.71	2.8	0.228478
K vs. pH	2256	4.133	69.3486	0.000000	0.116	543367.2	0.000000
K vs. AA	2256	311.4	58.2205	0.000000	20.71	17.2	0.003043
Ca vs. pH	21.6	4.133	9.8935	0.000000	0.116	1604.5	0.000000
Ca vs. AA	21.6	311.4	-36.1176	0.000000	20.71	19.7	0.002103
Mg vs. pH	263.0	4.133	12.7919	0.000000	0.116	211009.0	0.000000
Fe vs. pH	**7.60**	**4.133**	**0.9761**	**0.348273**	**0.116**	**6489.8**	**0.000000**
Fe vs. AA	7.60	311.4	-35.3485	0.000000	20.71	4.9	0.075565
Mn vs. pH	0.494	4.133	-69.2890	0.000000	0.116	2.4	0.315382
Mn vs. AA	0.494	311.4	-39.7201	0.000000	20.71	75106.1	0.000000
Zn vs. pH	1.121	4.133	-27.6533	0.000000	0.116	5.1	0.067600
Zn vs. AA	1.121	311.4	-39.6370	0.000000	20.71	6178.1	0.000000
Cu vs. pH	1.496	4.133	-5.6196	0.000113	0.116	112.4	0.000014
Cu vs. AA	1.496	311.4	-39.5221	0.000000	20.71	280.7	0.000001

*AA – Ascorbic acid

There are many physic-chemical parameters that allowed to statistically differentiating some tomatoes assortments. The minerals

present only a few significant differences according to the assortments but correlating with pH or ascorbic acid we can obtain significant differences.

Because K variables and ascorbic acid measurements have larger values than the other analysed variables we need to transform data to square roots in order to perform PCA (figures 1 and 2).

PRINCIPAL COMPONENTS ANALYSIS
Data square-root transformed;
Tolerance of eigenanalysis set at 000001
PCA case scores

	Axis 1	Axis 2
Na	0.475	-0.001
K	2.878	-0.011
Ca	0.281	-0.013
Mg	0.978	0.048
Fe	**0.146**	**0.069**
Mn	0.043	-0.001
Zn	0.064	-0.004
Cu	0.068	-0.012
pH	0.123	-0.001
Ascorbic acid	1.069	-0.019

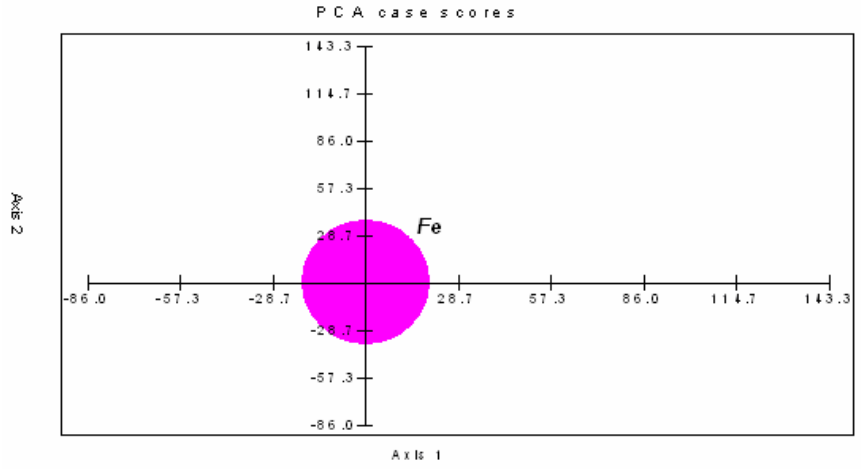

Fig. 1. Graphical representation of PCA case score analysis

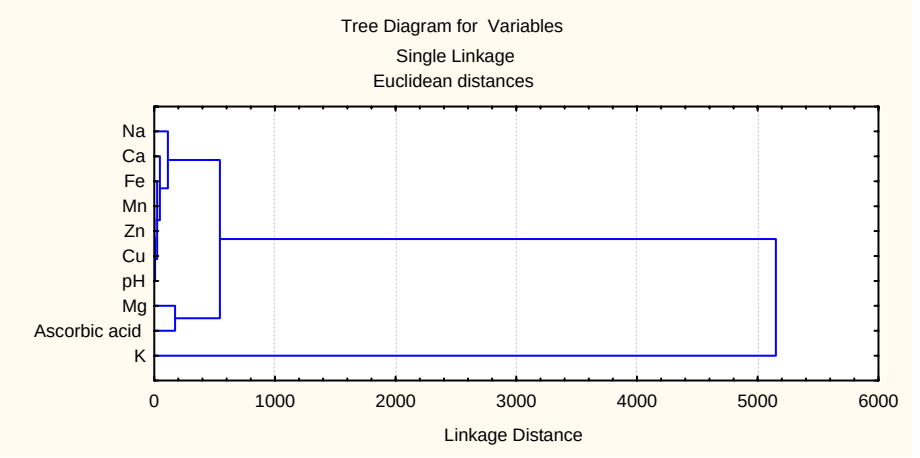

Fig. 2. Tree diagram of variables

PCA is showing that Fe is the variable that should be used to describe the variability between tomatoes assortments.

Conclusions

By using the Tree Diagram for variables on the basis of Euclidean Distances we conclude that the high content in potassium could also become a parameter to detect the variability of different assortments of tomatoes because of its high and variable content.

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