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Statistical Differentiation of Bananas According to Their Mineral Composition

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The concentrations of Na, K, Ca, Mg, Fe, Cu, Zn, and Mn were determined in banana cultivars Gran enana and Pequeña enana cultivated in Tenerife and in cv. Gran enana bananas from Ecuador. The mineral concentrations in the bananas from Tenerife and from Ecuador were clearly different. The cultivar did not influence the mineral concentrations except in the case of Fe. Variations according to cultivation method (greenhouse and outdoors) and farming style (conventional and organic) in the mineral concentrations in the bananas from Tenerife were observed. The mineral concentrations in the internal part of the banana were higher than those in the middle and external parts. Representation of double log correlations K−Mg and Zn−Mn tended to separate the banana samples according to origin. Applying factor and cluster analysis, the bananas from Ecuador were well separated from the bananas produced in Tenerife, and therefore, these are useful tools for differentiating the origin of bananas.

KEYWORDS: Mineral composition; banana; cultivars; cultivation method; organic; conventional; mineral intake; Tenerife; Ecuador

INTRODUCTION

Approximately 70% of the total world production of bananas comes from Latin America, and mainly Ecuador produces about 30% of all the bananas from Latin America. The banana is also one of the most important agricultural products of the Canary Islands, contributing 3.4% to the world trade. The cultivation of bananas is very important in the Canary Islands because of their high consumption, as well as for economic and traditional reasons. Approximately 20% of agricultural land in the Canary Islands is used for banana production, and Tenerife represents a third of the total production. The nutritional value of bananas is high, as its consumption is very healthy for all ages (*1*).

Basically, there are two banana cultivars produced in the Canary Islands: Gran enana and Pequeña enana, each belonging to *Musa acuminata AAA* (sub-group cavendish) and included in the family of Musaceae. Organic bananas are produced according to the European regulations of ecological plantation (*2*), which regulates the use of fertilizers and antiparasitic products, imposes water regulations, and controls the production and commercialization. Each year in the Canary Islands about 500 tons of bananas are produced according to these regulations. Most ecological plantations are less than one hectare and the main problems are the parasites and less effective fertilization, which increase the costs, especially the labor.

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The chemical characterization of food products can permit their differentiation according to geographic origin. Research on the determination of the geographic origin or quality brand of food products is a very active area for the application of chemometric classification procedures (*3*). Objective physicochemical parameters are currently used for the classification and differentiation of food samples. The chemical composition and the nutritive value of bananas is influenced by many factors such as the production area, cultivar, soil and climate, agricultural practices, the quality of water for irrigation, and storage and commercialization conditions. It is scientifically accepted that the mineral and trace metal composition of fruits and vegetables is a distorted reflection of the trace mineral composition of the soil and environment in which the plants grow. Therefore, it can be used as a criteria to distinguish the geographic origin of bananas, as the mineral composition of soils changes depending on the region considered.

We determined the concentrations of Na, K, Ca, Mg, Fe, Cu, Zn, and Mn in bananas from Tenerife and Ecuador in order to differentiate them. The contribution to the human diet mineral intake due to the current consumption of bananas in the diet was estimated. In addition, the bananas from Tenerife were classified according to the cultivation method and farming style using the mineral contents. A statistical study of correlation, factor analysis, and cluster analysis was carried out on the mineral data in order to separate the banana samples into homogeneous groups.

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Table 1. Descriptions of the Banana Samples According to Farming Style, Cultivation Method, and Location of Farms

		farming style		cultivation method		location of farms	
origin/cultivar	*N*	conventional	organic	outdoors	greenhouse	south	north
Tenerife	95					73	22
Gran enana	36	yes	no	18	18	36	0
Pequeña enana	59			41	18	37	22
	10	no	yes	10	0	0	10
	49	yes	no	31	18	37	12
Ecuador	16						

MATERIALS AND METHODS

Samples. One hundred and eleven samples of bananas were analyzed: 95 were cultivated in the island of Tenerife and 16 were cultivated in Ecuador. Source and growing conditions of the banana samples are described in **Table 1**. The samples ($n = 59$) of Pequeña enana can be divided according to conventional ($n = 49$) and organic ($n = 10$) cultivation types. The samples from Tenerife were provided by Cooperativa de Plátanos de Canarias (COPLACA) from 52 different farms located in various regions of the island of Tenerife. Gran enana and Pequeña enana cultivars produced in Tenerife were analyzed. The sampling was carried out between March 2000 to November 2001. Samples were taken from the second "layer" of the superior part of a banana bunch. The "layers" were cut when they were green (ripening color: point n*o*. 1) (*4*) with a minimum length of 13 cm. The layers were ripened in the laboratory using Ketefon (Kenogakenogard, S. A., Barcelona) and stored in chambers at room temperature. When the color of the banana samples was "yellow" (ripening color: point n*o*. 6) (*4*) and the full flavor and adequate conditions for its consumption were observed, the calibre and length were determined. The sixteen samples from Ecuador were acquired on different days from Mercamadrid between June and September 2001, presenting the same characteristics (ripening color: point no. 1) as the bananas from Tenerife, and they were ripened in the same way.

Eight bananas from Tenerife were also analyzed, differentiating the following three parts: (1) external, approximately 1 mm of the surface part is considered; (2) middle, the pulp of the fruit understood to be that part between the external and internal parts; and (3) internal, the central part (0.5 cm of diameter) including the seeds is taken.

Analytical Methods. Mineral contents were determined using a Varian Spectra AA-10 Plus atomic absorption spectrometer equipped with a D_2 lamp background correction system. Determinations were carried out in triplicate. Three or four bananas from a hand were homogenized, and an aliquot part was weighed and desiccated at 55 °C until constant weight. After, between 1 and 1.2 g of dried banana sample was weighed into digestion tubes and 8 mL of HNO_3 Suprapure (Merck) was added. The mixture was heated into a digestion block in the following sequence: 100 °C, 20 min; 125 °C, 20 min; 140 °C, 20 min; 150 °C, 20 min; 160 °C, 60 min; and 170 °C, 15 min. After the mixture was cooled at room temperature, 0.5 mL of HCl Suprapure (Merck) was added, and the mixture was heated to 170 °C for 5 min. Then, this solution was quantitatively transferred and adjusted to 10 mL with ultrapure water. For the determination of K, Ca, and Mg it was necessary to make a new dilution, taking 1 mL of the concentrated solution and adjusting it to 10 mL with ultrapure water. Calcium, Mg, Fe, Cu, Zn, and Mn were determined by atomic absorption spectrometry, and Na and K were determined by atomic emission spectrometry using the instrumental conditions recommended.

Quality Control. Wheat flour reference material (ARC/CL3, LGC Deselaers) was used for the metals, except for Mn. Quality control for Mn was checked using banana samples spiked and not spiked with known amounts of Mn standard. The percent of recovery ranged from 98.5% to 101.5%. Coefficients of variations were always <5%, ranging between 2.9 and 4.8%. The contents of the metals in the banana samples were clearly higher than the detection and the determination limits observed. Therefore, the determinations are sufficiently accurate, precise, and safe.

Statistics. All statistical analyses have been performed by means of the SPSS version 10.0 software for Windows. The Kolmogorow−Smirnov test was applied to verify whether the variable had a normal distribution, $p < 0.05$. The mean values obtained in the different groups were compared by one-way ANOVA and *t* test, assuming that there were significant differences between mean values when statistical comparison gave $p < 0.05$. Simple linear and logarithmic correlation analysis was used to indicate a measure of the correlation and the strength of the relationship between two variables. Factor analysis, using principal components as the method for extraction of factors, was used to summarize the information in a reduced number of factors. Cluster analysis was used to search the natural groupings among the samples. The sample similarities were calculated on the basis of the squared Euclidean distance, and the Ward method was used to establish clusters.

RESULTS AND DISCUSSION

The mineral concentrations of Gran enana (GE) and Pequeña enana (PE) bananas were similar regardless of cultivation practices (**Table 2**). The only detectable difference was for Fe, which was higher ($p = 0.011$) in GE than in PE. There are probably other factors such as the nature of the soil or the climatic conditions that have more effect on Fe content than the cultivar. These agro-climatic conditions are the main factors influencing the mineral contents in vegetable foods reported for different regions in the world. Similar to other vegetable foods,

Table 2. Metal Average Concentrations (mg/kg of Whole Pulp of Banana) for the Different Groups of Banana from Tenerife Studied

cultivar	Na	K	Na/K × 100	Ca	Mg	Fe	Cu	Zn	Mn
				Gran enana					
total	36[a]	36	36	35	36	34	36	35	36
	1.79 ± 0.73[b]	5015 ± 574	0.356 ± 0.134	40.8 ± 15.0	389.6 ± 37.9	3.09 ± 0.74	0.791 ± 0.192	1.57 ± 0.39	0.633 ± 0.282
greenhouse	18	18	18	18	18	17	18	17	18
	1.64 ± 0.52	4740 ± 448	0.351 ± 0.119	44.0 ± 15.4	383.0 ± 6.8	3.35 ± 0.60	0.853 ± 0.200	1.75 ± 0.29	0.754 ± 0.342
outdoors	18	18	18	17	18	17	18	18	18
	1.94 ± 0.88	5289 ± 558	0.362 ± 0.151	37.5 ± 14.1	396.2 ± 46.4	2.82 ± 0.79	0.729 ± 0.167	1.40 ± 0.40	0.512 ± 0.126
				Pequeña enana					
total[c]	49	49	49	48	49	47	48	49	49
	1.66 ± 0.668	5109 ± 684	0.333 ± 0.156	42.1 ±9.4	377.9± 43.2	2.79 ± 0.656	0.806 ± 0.270	1.56 ± 0.356	0.645 ± 0.260
greenhouse	18	18	18	17	18	17	18	18	18
	1.54 ± 0.67	5313 ± 785	0.297 ± 0.155	39.1 ± 7.61	370.3 ± 33.5	2.85 ± 0.655	0.779 ± 0.185	1.53 ± 0.312	0.619 ± 0.318
outdoors									
conventional	31	31	31	31	31	30	30	31	31
	1.73 ± 0.667	4991 ± 600	0.344 ± 0.119	43.8 ± 10.0	382.3 ± 48.0	2.76 ± 0.665	0.821 ± 0.311	1.57 ± 0.384	0.659 ± 0.225
organic	10	10	10	10	10	10	10	10	10
	1.68 ± 1.04	4723 ± 359	0.362 ± 0.244	53.2 ±1 2.1	395.0 ± 39.4	2.27 ± 0.436	0.620 ± 0.121	1.64 ± 0.479	0.563 ± 0.110

[a] Number of cases. [b] Mean ± deviation standard. [c] Organic samples not included.

Table 3. Mineral Average Concentrations (mg/kg) for the Different Zones of the Banana[a]

part	no.	Na	K	Ca	Mg	Fe	Cu	Zn	Mn
external	8	3.36 ± 0.875ab	4692 ± 427a	33.6 ± 11.7a	364.6 ± 55.2a	2.44 ± 0.52a	0.268 ± 0.115a	0.99 ± 0.21a	0.537 ± 0.161a
middle	8	2.91 ± 0.703a	4602 ± 225a	33.1 ± 10.5a	400.1 ± 52.9a	2.45 ± 0.40a	0.353 ± 0.134a	1.12 ± 0.24ab	0.499 ± 0.179a
internal	8	4.12 ± 1.86b	4783 ± 416a	50.8 ± 24.2b	405.9 ± 53.0a	2.43 ± 0.370a	0.473 ± 0.142b	1.27 ± 0.27b	0.759 ± 0.394b

[a] Results in the same vertical line with the same letter were not significantly different ($p < 0.05$).

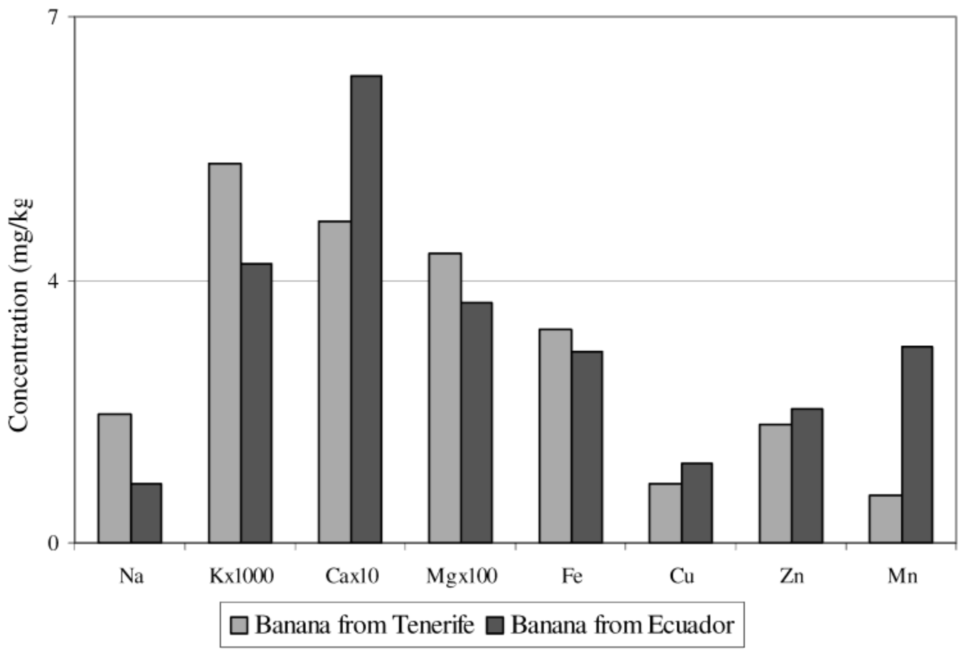


Figure 1. Mean concentrations of the analyzed minerals in bananas from Tenerife and in bananas from Ecuador.

K was the most abundant mineral followed by Mg, Ca, and Na. Our data on K were higher than all the data reported in different regions of the world (*5*, *6*), however, they agree with data recently published for bananas from Tenerife (*7*). In contrast, the Na concentrations were relatively low compared to those in other published data (*7*, *8*). The Na/K ratio calculated for the bananas was also rather low, and this point seems important because some physiological and epidemiological data suggest that a high Na/K ratio in an individual may be linked to an increase risk of developing high blood pressure and cardiovascular disease (*9*). Therefore, the consumption of Canary bananas could play a positive role in the prevention and treatment of these diseases. The concentrations of Ca and Mg obtained in this work are in the same range of those described by other authors in other areas of the world (*5*−*6*, *8*). Previous data of Mg reported for bananas from Tenerife agree with ours, but the levels indicated for Ca were much higher (*7*). In general, the levels of the trace elements studied here tend to be lower than those of the data published in other countries (*5*−*7*). The levels of Fe and Zn were similar to those described for bananas from Tenerife (*7*), but the concentrations of Mn and Cu were below the ranges described by these authors.

Samples of Gran enana cultivated in greenhouse had higher ($p < 0.05$) mean contents of the trace elements studied than bananas planted outdoors, and these had higher contents of K, Na, and Mg, although the differences were significant only for K ($p = 0.003$). The banana samples belonging to the cultivar Pequeña enana behaved differently. So, the greenhouse bananas had higher ($p = 0.114$) and lower ($p = 0.096$) mean concentrations of K and Ca, respectively, than the outdoor bananas. This could be due to differences in growing conditions, e.g., in the soils, for the two cultivars and the two cultivation methods. The cultivation style (conventional or organic) in the samples of outdoor Pequeña enana displayed an interesting influence on the mineral composition of the bananas, and consequently, on its nutritional value. So, organic bananas had lower ($p < 0.05$) mean concentrations of Fe and Cu, and a higher ($p = 0.019$) mean value of Ca than the conventional bananas. Besides, the conventional bananas had more Na, K, and Mn, and less Mg and Zn than the organic ones, although in these cases no significant differences were observed.

According to **Table 3** the metal concentrations in the edible portions of the bananas show important variations as a function of the part of the banana considered. In general, the internal part showed a higher concentration of the metal studied than the other two parts considered. This could be related to the fact that the seeds of the bananas are situated in the internal part. It is well-known that, in general, the seeds of fruits have a higher mineral content than the pulp. The mean contents of Fe, K, and Mg did not vary significantly according to the part of the banana. The internal part of the bananas had higher ($p < 0.05$) mean contents of Cu and Zn than the middle part, and this had higher ($p < 0.05$) mean contents than the external part. The Na, Ca, and Mn mean concentrations in the internal part of bananas were also higher ($p < 0.05$) than the mean contents observed in the other two areas, between which no significant differences were found.

Figure 1 shows the mean concentrations of the metals analyzed for the Gran enana harvested in Tenerife and bananas imported from Ecuador. Important differences were observed between the mean contents for all the metals analyzed. Therefore, a strong influence of the origin of the banana samples on the mineral content was observed, which agrees with previous work reported in the literature (*5*, *7*, *10*). These results confirm

Table 4. Contribution to Daily Dietary Intake of Na, K, Ca, Mg, Fe, Cu, Zn, and Mn of the Adult Population for the Consumption of 100 g of Canary Banana and Banana from Ecuador

metal	RDA[a] or ESADDI[b] (mg/day)	Canary banana intake (mg/day)	Canary banana % of RDA	banana from Ecuador intake (mg/day)	banana from Ecuador % of RDA
Na	500–3000	0.17	0.034–0.006	0.08	0.02–0.003
K	2000[c]	503.3	25.2	372.3	18.6
Ca	800	4.3	0.54	6.2	0.78
Mg	350 (280)	38.4	11.0 (13.7)	32.0	9.1 (11.4)
Fe	10 (15)	0.28	2.8 (1.9)	0.26	2.6 (1.7)
Cu	1.5–3	0.08	5.2–1.9	0.11	7.1–3.6
Zn	15 (12)	0.16	1.0 (1.3)	0.18	1.2 (1.5)
Mn	2–5	0.06	3.2–1.3	0.26	13.1–5.2

[a] RDA = Recommended daily allowance. [b] ESADDI = Estimated safe and adequate daily dietary intake range.

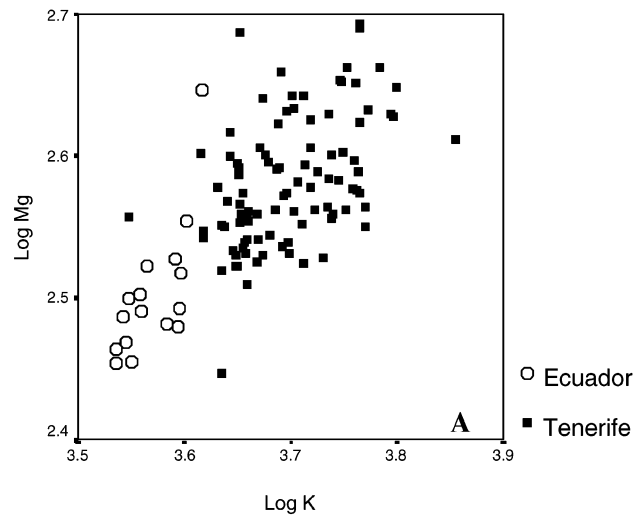
Table 5. Double Logarithmic Matrix Correlation for All the Samples (When $p > 0.05$ Values Are Not Shown in the Table)

	Log Na	Log K	Log Ca	Log Mg	Log Fe	Log Cu	Log Zn	Log Mn
Log Na		0.474[a]	–0.348	0.330	0.197			–0.416
		0.000[b]	0.000	0.000	0.042			0.000
		111[c]	109	111	107			111
Log K			–0.428	0.655	0.218			–0.501
			0.000	0.000	0.024			0.000
			109	111	107			111
Log Ca							0.411	0.542
							0.000	0.000
							108	109
Log Mg					0.238		0.238	–0.369
					0.014		0.012	0.000
					107		110	111
Log Fe							0.379	
							0.000	
							106	
Log Cu							0.313	0.389
							0.001	0.000
							109	110
Log Zn								0.308
								0.001
								110

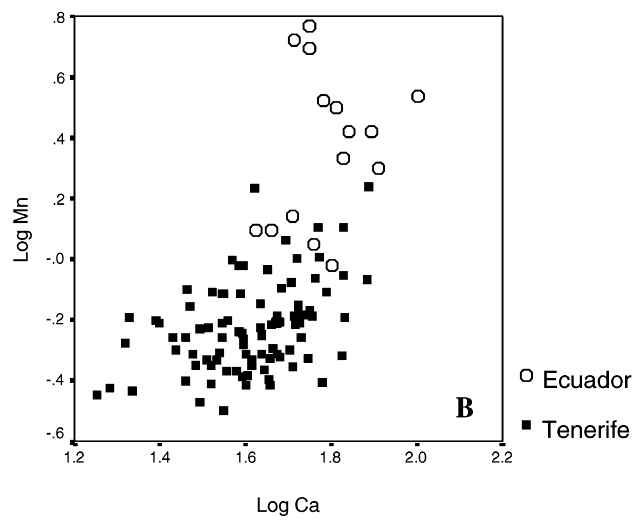
[a] Coefficient correlation of Pearson. [b] Signification level. [c] Number of pairs.

the importance of the recommendation indicated by The United Nations Organization for Food and Agriculture (FAO) about the preparation of food composition charts of food produced and consumed locally. On the other hand, the bananas from Tenerife can be characterized according to the mineral content. So, bananas from Tenerife presented higher ($p < 0.001$) mean contents of electrolytes (Na and K), Mg, and Fe, and the bananas from Ecuador had higher ($p < 0.05$) contents of Ca, Cu, Zn, and Mn. These important differences could be explained by the mineral composition of the soil. The Na/K ratio calculated for the bananas produced in Tenerife was higher ($p = 0.000$) than the ratio observed for the bananas from Ecuador, although in both cases the values found were rather low.

The mean consumption of bananas in the Canary population is estimated at 25 g/person/day (*11*). But, there is a large segment (≈25%) of the consumers who consume nearly 100 g daily (edible portion of a medium-sized banana). **Table 4** shows the contribution to the dietary daily intake of the metals studied in relation to the recommended daily allowance (RDA) or estimated safe and adequate daily dietary intake range (ESADDI) values by the consumption of one medium-sized banana. The contribution to the K and Mg intake was rather large for the consumption of bananas from Tenerife, with 25.2% for K and 11.0 (13.7%) for Mg of the RDA observed, which represented



LogMg = 0.652 + 0.521 LogK r = 0.655



LogMn = -1.812 + 1.019 LogCa r = 0.542

Figure 2. Plot of double logarithmical correlation between logK and logMg (A) and between logCa and logMn (B) differentiating the procedence.

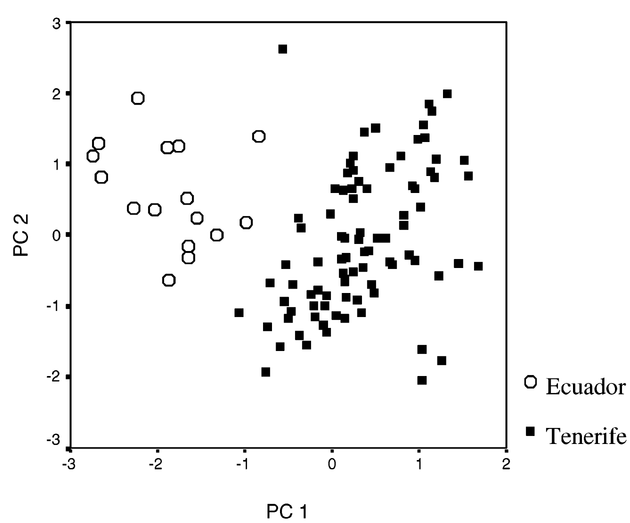


Figure 3. Scores of the banana samples on axes representing the two PC differentiating the procedence.

a higher contribution than that of bananas from Ecuador. On the other hand, the bananas from Ecuador would contribute a

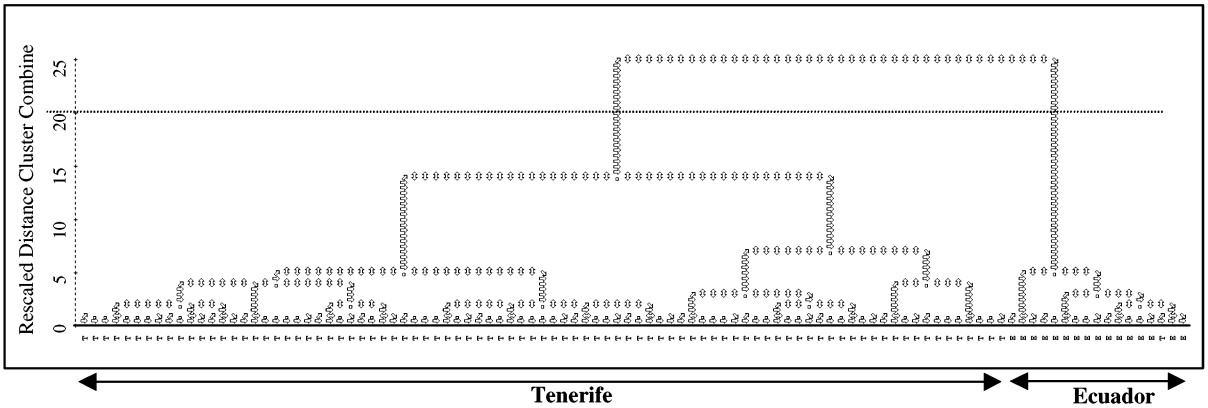


Figure 4. Dendogram of the cluster analysis.

Table 6. Factor Matrix Obtained after a Varimax Rotation

variable	PC 1	PC 2
K	0.850	–0.039
Mg	0.726	0.351
Mn	–0.715	0.387
Na	0.596	–0.047
Ca	–0.528	0.506
Zn	–0.026	0.848
Fe	0.362	0.631
Cu	–0.212	0.554

significantly higher amount in Mn and Cu. However, the contribution of the current consumption of the banana to the intake of trace metals in human beings is, in general, fairly low. Therefore, if the food habits for the Canary population change and the consumption of bananas increases, the contribution to the daily intake of minerals would increase, in particular of K and Mg, which are associated with the prevention of cardiovascular diseases (*9*).

The double logarithmic correlation matrix (**Table 5**) shows the presence of a high number of significant ($p < 0.05$) correlations between the minerals. Manganese showed significant correlations with all the metals studied, except Fe. In contrast, Cu showed significant correlations only with Fe and Mn. Most of the correlations were positive; however, negative correlations were observed between the electrolytes with the Ca and with the Mn. Among the correlations defined, the following correlations can be pointed out: logK−logMg and logCa−logMn, because of the high correlation coefficients and significance. These correlations and the equations defined are shown in **Figure 2A,B** differentiating the banana samples according to their origins. These figures show that the bananas from Tenerife tend to separate graphically from the bananas from Ecuador which is due to the clear differences in the mineral contents considered in these correlations. Therefore, the bananas from Tenerife showed high concentrations of K and Mg (**Figure 3A**) and low concentrations of Ca and Mn (**Figure 3B**).

Factor analysis using the principal components as method for the extraction of factors was applied to all the samples of banana studied to obtain a more simplified view of the relationship among the metals considered. The first two principal components (PCs) were chosen (56.8% of the total variance) because their eigenvalues were higher than 1, and therefore, they explain more variance than the original variables. A Varimax rotation was carried out to minimize the number of variables that influence each factor and then facilitate the interpretation of the results (**Table 6**). The first PC that explains the higher percentage of variance (33.4%) is associated with K and to a lesser extent to Mg and inversely to Mn. The second PC is heavily related with Zn. The scores plot for all the banana samples of the representation of these two factors is shown in **Figure 3**. It can be observed that the samples of bananas from Ecuador are separated graphically from the bananas produced in Tenerife. No separation was observed between the cultivars Gran enana and Pequeña enana of the bananas produced in Tenerife. The results obtained in the cluster analysis are presented as a dendrogram in **Figure 4**. Considering a distance of 20, two clusters can be identified as follows: the first cluster (1) is composed of banana samples from Tenerife; and the second cluster (2) contains 17 samples. All the samples included in this second cluster, with the exception of one banana sample from Tenerife, correspond to bananas from Ecuador. Therefore, a clear separation of the banana samples as a function of the origin of the samples was observed which agrees with the results obtained in the factor analysis. Within the first cluster, no clear tendencies to grouping the banana samples in other factors were observed.

CONCLUSIONS

Mineral contents in the bananas are heavily influenced by the location of their cultivation. The mineral contents of the soils seem to have a major influence on the mineral content of bananas. Therefore, the use of multivariate analysis on mineral concentrations is a useful tool for determining the origin of the bananas.

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LITERATURE CITED

(1) Asprocan. *Statistical Data*. Association of Organization of Banana Producers, 2001.
(2) Council Regulation (EEC), n*o*. 2092/91, June 24, 1991.
(3) Ashurst, P. R.; Dennis, M. J. *Food Authentication*; Chapman and Hall: London, 1996.
(4) COPLACA. Cooperativa de plátanos de Canarias. Postcosecha del plátano; Litomaype, S. L.; Tenerife, Canary Islands, 1994.
(5) Kodia, A. A.; Irigaray, J. L.; Dejou, J. Recherche analytique d'éléments mayeurs et d'óligoéléments dans la banane, l'avocat, l'ignane et l'attiéké de Côte divoire, par radiactivation avec des neutropes de 14 Mev. *Fruits* **1979**, *34*, 131−134.

(6) Sánchez-Castillo, C. P.; Dewey, P. J. S.; Aguirre, A.; Lara, J. J.; Vaca, R.; Leon de la Barra, P.; Ortiz, M.; Escamilla, I.; Philip, T. J. The mineral content of Mexican fruits and vegetables. *J. Food Compos. Anal.* **1998**, *11*, 340−356.

(7) *7*) Hardisson, A.; Rubio, C.; Baez, A.; Martin, M.; Alvarez, R.; Diaz, E. Mineral composition of the banana (*Musa acuminata*) from the island of Tenerife. *Food Chem.* **2001**, *73*, 153−161.

(8) *8*) Wills, R. B. H.; Lim, J. S. K.; Greenfield, H. Composition of Australian foods. Tropical and subtropical fruits. *Food Technol. Aust.* **1986**, *38*, 118−123.

(9) Krummel, D. Nutrición en la hipertensión. In *Nutrición y dietoterapia de Krause*, 10th ed.; Mahan, L. K., Escott-Stump, S., Eds.; McGraw-Hill: México, 2000; pp 649−664.

(10) Gates, E.; Lehmann, J. Mineral composition of fruits. *J. Am. Dietetic Assoc.* **1968**, *52*, 225−231.

(11) Serra-Majem, L.; Armas, A.; Ribas, L. *Encuesta nutricional de Canarias 1997−98, vol. 1., Hábitos alimentarios y consumo de alimentos*; Consejería de Sanidad y Consumo, Gobierno de Canarias: Santa Cruz de Tenerife, Canary Islands, 1999.

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