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Mineral composition of the banana (*Musa acuminata*) from the island of Tenerife

A. Hardisson [a,*], C. Rubio [a], A. Baez [a], M. Martin [a], R. Alvarez [b], E. Diaz [c]

[a] Area de Toxicologia, Facultad de Farmacia, Universidad de la Laguna, Tenerife, Spain
[b] Area de Medicina Preventiva y Salud Pública, Facultad de Medicina, Universidad de La Laguna, Tenerife, Spain
[c] Instituto de Investigaciones Agrarias, Valle de Guerra, Tenerife, Spain

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Abstract

The content of major (Na, K, Ca, Mg and P) and minor elements (Fe, Cu, Zn, Mn and B) in bananas consumed on the island of Tenerife, Canary Islands, has been determined. Significant differences were observed in the mineral contents of the banana samples, with higher K, Mg, P, Fe, Cu, Zn and B levels in the banana grown in north Tenerife and a higher Ca content in the banana originating in the south of the island. Differences between these mineral contents and the fruit reported in the literature have been established and a comparison has been carried out with diverse food composition tables. The banana is shown to contribute to the recommended daily requirements of K, Mg, Cu and B.

1. Introduction

The importance of optimal intakes of essential mineral elements to maintain peak health is widely recognized (Avioli, 1988). Inadequate intake of mineral elements has been observed to be a major nutritional problem in our environment (Aremu & Udoessien, 1990).

Fruits and vegetables are an important source of essential elements (Tahvonen, 1993), Minerals play a vital role in the proper development and good health of the human body and fruits are considered to be the chief source of minerals needed in the human diet (Chauhan, Pundir & Singh, 1991).

The risk of deficiencies and attendant pathologies depends on a number of factors such as the daily dietary intake, the chemical form of the minerals contained in the food consumed, the technological treatment of the products, the presence of substances that limit or increase the bioavailability of minerals and the physiological state and overall health of the consumer (Barbera, Farré & Lozano, 1992).

Studies of the role of diet in the etiology of such deficiencies have occasionally been hindered by the absence of data on the mineral content of the food actually consumed since the values included in food composition tables are frequently based on non-representative samplings, referring to food of foreign origin, or the data were obtained with analyses and methodology that may require updating. The literature already offers a fair amount of information on the levels of some of the inorganic elements found in green leafy vegetables and fruits (Aremu & Udoessien, 1990).

There are slight variations in the contents of these minerals as reported by various workers, These variations could be attributed to the fact that the fruits proceed from different agro-climatic conditions prevailing in different sectors of the world (Chauhan et al., 1991). In view of the above, both national and international organizations have addressed these problems with the aim of helping nutrition experts by establishing the guidelines to be followed. Thus, the United Nations Organization for Food and Agriculture (FAO) has recommended that food composition charts be prepared for food produced and consumed locally.

Many factors affect the elemental contents of plants, for example, variety, state of ripeness, soil type, soil condition, fertilization, irrigation and weather (Tahvonen,

* Corresponding author. Tel.: +34-22-319372; fax: +34-22-319279.

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1993). In this regard, several authors (Chauhan et al., 1991; Ellen et al., 1990; Ferguson et al., 1989; Gates & Lehmann, 1968; Jorhem et al., 1993; Kodia, Irigaray & Dejou, 1979; Monro et al., 1986; Sanchez-Castillo et al., 1998; Tahvonen; Wills, Lim & Greenfield, 1986) have demonstrated the variations of nutrient composition among and within the existing species, depending on the characteristics of the land, climate, cultivation conditions and methods and on the stage of maturation. A study carried out in India demonstrated that the total ash content of banana pulp increased gradually with the advancement in maturity and, while Ca, Na, K and Fe in the pulp of different varieties of banana showed a declining trend, P showed an increasing trend with maturity (Wadud & Labsar, 1996). Another study showed how most of the minerals were higher during the earlier stages of development and declined towards maturity (Goswami & Borthakur, 1996). Likewise, modern agricultural practices and the commercialization of new varieties can modify the concentrations of the different mineral elements in fruits and vegetables.

Fresh fruit and vegetables form an important part of the diet of all age groups in Spain, constituting an appreciable source of essential elements and providing between 12 and 18% of the total dietary mineral intake. This percentage is about 15% in the Canary Islands (Doreste, 1987).

In light of the above and given the paucity of data on the mineral content of vegetable produce, of great importance to the economy of the islands, it seems worthwhile to study the concentrations of some minerals (Na, K, Ca, Mg, P, Fe, Cu, Zn, Mn and B) in the banana (*Musa acuminata*, Colla) cultivated and consumed on Tenerife island.

Although numerous studies have been carried out of the introduction of different varieties of banana (Galan, Mansito & Caballero, 1981; Galan, Garcia & Marrero, 1984; Galan, Hernández, Delgado & Cabrera, 1991; Blesa, Rodriguez & Maestre, 1976), practically the only variety grown is "Pequeña Enana" (Dwarf Cavendish), as reported by these same authors.

It is also important to know that Ecuador produces about 30% of all the bananas exported from Latin America and its annual production is about 2.2 million tons. Besides this, a special variety of banana, which is used extensively for cooking, called plantain, is also grown in Ecuador (Ruales, Pólit & Nair, 1990).

Bananas are the main crop in the Canary Islands, with a total of 9300 hectares entirely under irrigation. The mean production over the sampling period of this work amounted to about 416 000 mTm per year. 75 000 mTm are grown on a single island in the province of Las Palmas de Gran Canaria, that of Gran Canaria, where 15 000 hectares are devoted to this crop. 341 000 Tm come from the province of Santa Cruz de Tenerife, the production of which is more evenly distributed among the four islands that comprise it. Tenerife, with 4600 hectares, where 60% of the total area of farmland is devoted to the banana crop, is the main source, providing 60% of the total production of the province and 50% of that corresponding to the entire archipelago.

2. Materials and methods

2.1. Samples

In this work a total of 60 samples have been analysed: 30 grown in the south of the island, where the main plantations are located, and 30 purchased fresh in the main Mercatenerife wholesale market that receives fruit from the entire island and is the primary outlet. The latter samples were collected in order to include the less important crops typical of the banana-growing areas. The samples from the south area were taken randomly from different plants and always in triplicate, ensuring that all the fruit had attained the same degree of maturity. The samples purchased in Mercatenerife were also chosen at random, but their origin could not be established.

2.2. Statistical analysis

The possible differences between the two areas of origin of the bananas, regarding the content in minor and major elements, were evaluated by means of MANOVAs and, in the case of each of certain mineral elements, by means of ANOVAs, both as a function of the independent variable of area of origin (north vs. south). In the event of significant differences in the latter analysis, the Tukey test of average multiple comparison was used to know their direction and, for the former, discriminating analyses based on canonical functions and structure coefficients were used, apart from subsequently-planned contrasts by means of the compound multipticator variable.

Statistics were obtained by using the SPSS/PC+ statistical package (Manzano, 1993).

2.3. Determination of Na, K, Ca, Mg, Fe, Cu, Zn and Mn

An atomic absorption spectrophotometer by Perkin Elmer, model 3100, equipped with hollow-cathode lamps was used.

From each homogenized sample, 25 g were taken in duplicate for the study of the contents of iron, copper, zinc and manganese, and 10 g for sodium, potassium, calcium and magnesium, and taken to dryness overnight at 90±5°C in a thermostatted oven.

The organic matter was ashed in a muffle oven at 450±25°C. The resulting white ash was then dissolved in 2 ml of HCl 1:1 (v/v) and kept in an ultrasound bath until complete dissolution, later removing the acid excess remains by evaporation in a sand bath equipped with a thermostat. The residue was dissolved in deionized water and adjusted to a volume of 50 ml and 100 ml for the determination of micro and macroelements, respectively, the latter in 1:10 solutions.

Lantane chloride was added both to the acid solutions of the ashes and to the standard solutions in a final proportion of 1% (w/v), in order to avoid possible interferences in the determinations of the minerals (Ca and Mg).

The technique chosen was flame photometry for Na and K, and AAS (atomic absorption spectrometry) for the remainder of the studied mineral elements. In all cases an air acetylene flame was used.

2.4. P determination

The spectrophotometric method used was the molybdovanadate technique (AOAC, 1990), based on the capacity of P (in phosphoric acid form) in an acid solution and in the presence of Mo^{5+} and Mo^{6+} to form a yellow phosphomolybdovanadate complex (Pearson, 1976) whose absorbancy can be measured at 400 nm.

2.5. B determination

The determination of B was made following the quinalizarine method (AOAC, 1990). Quinalizarine in concentrated sulfuric acid reacts with boric acid to give rise to the formation of a purple-coloured complex, the absorbance of which can be measured spectrophotometrically at 620 nm. In these last two cases the instrument used was a Hewlett Packard 8452 A diode array spectrophotometer.

For all the determinations, analytical quality controls were carried out by using certified reference materials (MDR or SRM) (Table 1).

Table 1
Certified concentration values of SRM[a] 1515 of the NIST and concentration values obtained in this work

Element	Certified value (mean±S.D.)	Obtained value (mean±S.D.)	Units
Sodium	24±1.20	23.8±1.4	μg/g
Potassium	1.61±0.02	1.62±0.01	g%
Calcium	1.526±0.015	1.51±0.01	g%
Magnesium	0.271±0.008	0.26±0.05	g%
Copper	5.64±0.24	5.87±0.01	μg/g
Zinc	12.5±0.30	12.9±0.1	μg/g
Manganese	54±3	55.3±0.02	μg/g
Boron	27±2	26.1±0.96	μg/g
Iron[b]	80	81.5±0.01	μg/g

[a] SRM (Standard Reference Material) no 1515 (Apple Leaves) of the National Institute of Standards and Technology (NIST).

[b] Non-certified value, given only as a reference.

3. Results and discussion

Samples were gathered from March 1991 to January 1993, coinciding with peak production. A total of 120 samples (60 from each area of origin) was collected at random throughout the selected regions of the island.

3.1. Macroelements

The frequency distribution of the results obtained from the analysis of the 120 samples of banana pulp (*Musa acuminata* var Dwarf Cavendish), at concentration intervals (mg/100 g of edible portion), according to their area of origin, is summarized in Figs. 1–6 for the five major elements studied.

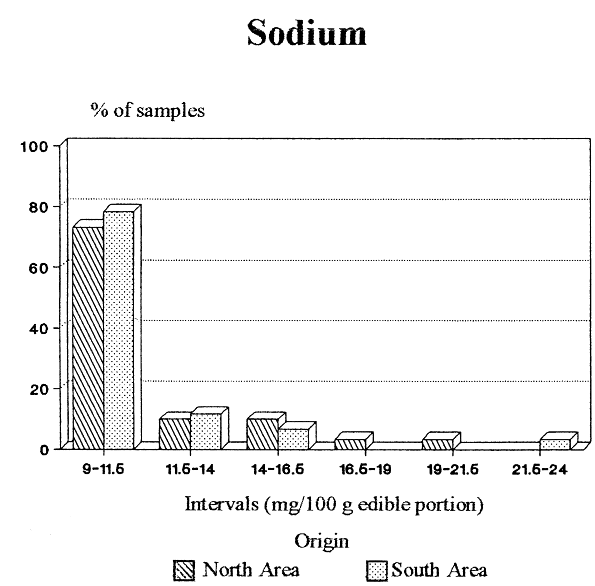


Fig. 1.

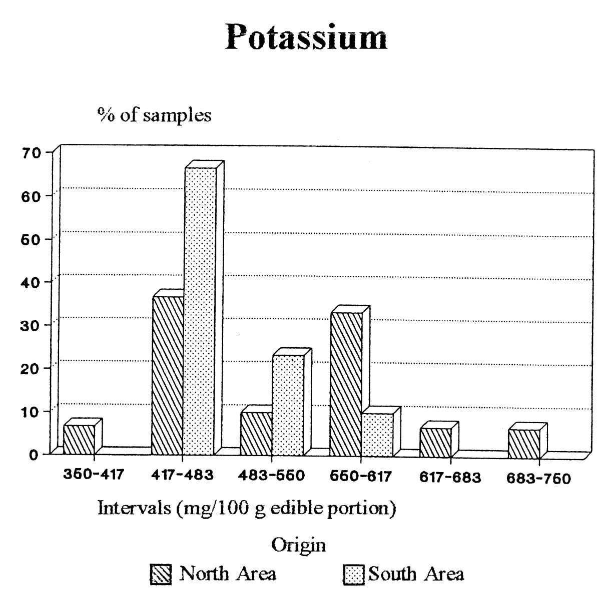


Fig. 2.

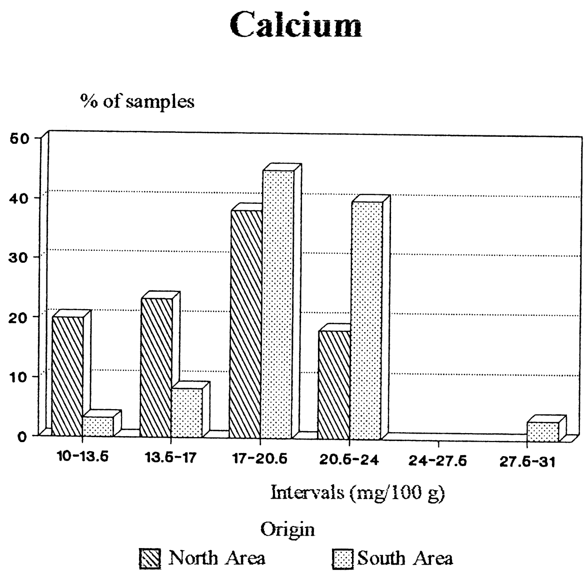
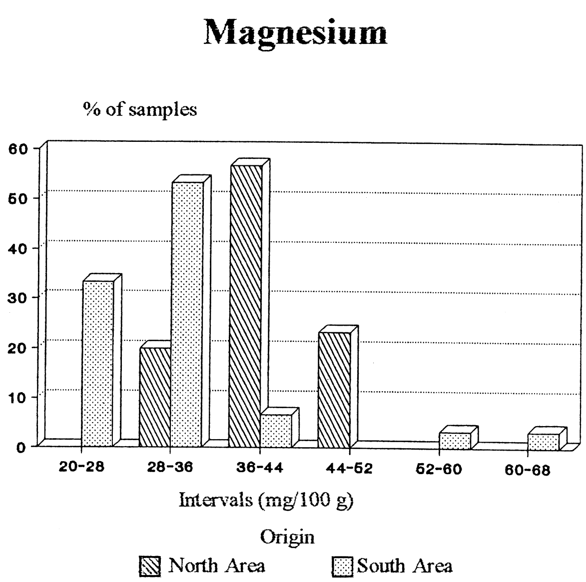


Fig. 3.



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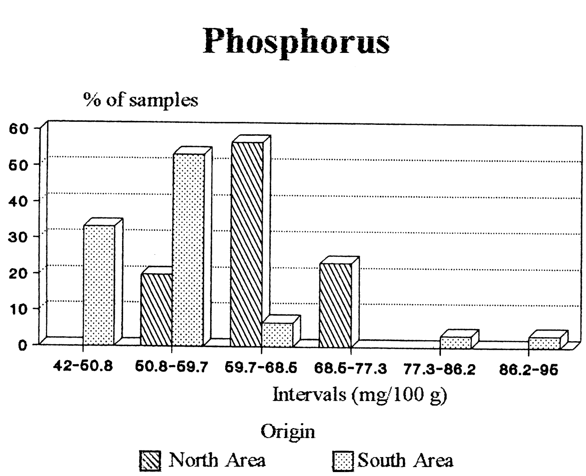

Fig. 5.

The frequency distribution is similar for both farming areas with regard to sodium concentration levels, since the biggest sample percentages (93%, in the north area and 96% in the south) are between 9.00 and 16.5 mg/100 g of edible portion. For the calcium, this phenomenon is even more clear, since 100% of the samples from the north area and 96.7% of the samples from the south of the island are between 10.0 and 24.0 mg/100 g.

However, for potassium and magnesium, larger percentages are found in samples coming from the north area, at higher concentrations.

Finally, in the distribution by intervals of phosphorus concentration, the data from the south were mostly (86.7%) obtained in the range 42.0–50.8–59.7 mg/100 g, while 100% of the samples coming from the north afforded values between 50.8 and 77.3 mg/100 g, that is to say, at higher concentrations.

All these comparisons are summarized in Table 5.

These data were evaluated by means of a multivariate analysis of the variance (MANOVA) with an independent variable (area of origin) with two variables (north vs. south), considering as dependent variables the concentration levels of the five major elements. A significant effect of the area of origin was manifested in the content of macroelements.

By means of a discriminating analysis, it was found that magnesium, phosphorus and potassium were responsible for the differences observed between both areas of origin. The comparative test subsequently performed with the compound multiplicator variable revealed that the contents of the five analyzed elements are significantly higher ($P < 0.001$) in the pulp of the banana from the north area of the island.

Moreover, the mean levels of concentration of each macroelement were subjected to several unvaried analyses of the variance (ANOVAs) with an independent variable (origin area), with two levels (north vs. south). A significant effect of the area of origin was found on

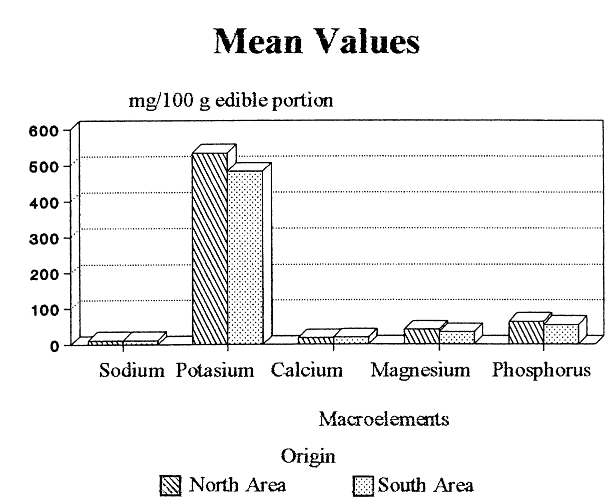

Fig. 6.

the contents of potassium, calcium, magnesium and phosphorus. The concentrations of potassium, magnesium and phosphorus were significantly higher in the samples from the south area than in those from the north, while the contents of calcium were higher in the samples collected in the south (Tables 2–4).

3.2. Microelements

From the data presented in Figs. 7–12 it can be seen that the percentage distribution of the samples at concentration intervals (mg/100 g of edible portion) of Fe, Cu, Zn, Mn and B is similar for both areas considered, although, in general, the samples from the north had greater percentages at higher concentration intervals.

After carrying out the same statistical study as performed earlier for macroelements, a significant effect of the area of origin of the samples was observed on the concentration of microelements in the banana pulp, which proved to be higher in the bananas cultivated in the north area of Tenerife.

Table 2
Mean values and standard deviations of macroelement and microelement concentrations (mg/100 g of edible portion) in banana pulp according to the area of origin of the samples

	North area	South area
Macroelements (mg/100 g)		
Sodium	12.0±2.60	11.4±2.81
Potassium	534±88.9	483±44.0
Calcium	17.9±3.73	19.9±3.23
Magnesium	41.2±10.9	33.6±3.39
Phosphorus	63.4±4.95	54.7±11.1
Microelements (mg/100 g)		
Iron	0.36±0.06	0.28±0.06
Copper	0.13±0.03	0.12±0.03
Zinc	0.18±0.04	0.16±0.04
Manganese	0.07±0.01	0.07±0.01
Boron	0.21±4.95	0.18±0.05

Table 3
Results of the unvaried analyses of variance (ANOVAs) of macroelement and microelement concentrations in banana pulp according to the area of origin of the samples

	F value (1118)	Significance
Macroelements		
Sodium	1.25	$P=0.265$
Potassium	16.1	$P<0.001$
Calcium	10.4	$P=0.002$
Magnesium	31.5	$P<0.001$
Phosphorus	30.5	$P<0.001$
Microelements		
Iron	39.9	$P<0.001$
Copper	6.57	$P=0.012$
Zinc	10.3	$P=0.002$
Manganese	0.02	$P=0.883$
Boron	7.00	$P=0.009$

In regard to the mean concentrations of these elements, the unvaried analysis of the variance (ANOVA) with an independent variable (origin area), with two variants (north vs. south), showed the existence of significant differences on the basis of the area of origin of the samples, the concentrations of iron, copper, zinc and boron, being greater in the bananas cultivated in the north (Tables 2–5).

These results are in accordance with those obtained by other authors in similar studies, for example Gates and Lehmann (1968), who found appreciable differences in the contents of sodium and manganese between lots of bananas coming from Ecuador and Jamaica. Briefly, the sodium presented extremely wide concentration ranges inside the same production area. Analogously to Kodia et al. (1979), remarkable variations were found in

Table 4
Summary of the minimum (min) and maximum (max) values obtained in the mineral concentrations of macroelements and microelements according to the origin of the banana samples

	North area		South area	
	Min	Max	Min	Max
Macroelements (mg/100 g)				
Sodium	9.27	21.2	9.08	23.9
Potassium	372	733	59	420
Calcium	10.1	24.0	10.5	30.8
Magnesium	21.2	67.5	26.5	42.8
Phosphorus	54.9	75.1	42.4	94.3
Microelements (mg/100 g)				
Iron	0.23	0.54	0.16	0.40
Copper	0.09	0.19	0.09	0.20
Zinc	0.10	0.24	0.11	0.22
Manganese	0.06	0.10	0.06	0.12
Boron	0.11	0.32	0.08	0.27

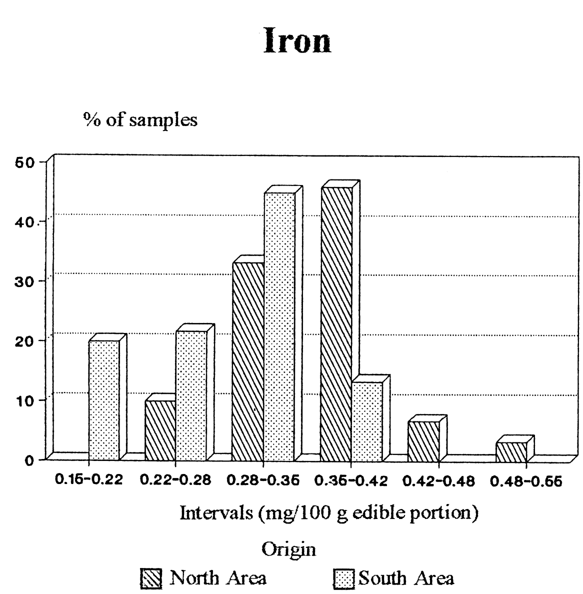

Fig. 7.

banana magnesium and manganese contents, according to the area of origin of the samples.

As occurs in any vegetable product, potassium was the most abundant major element, followed by phosphorus, magnesium, calcium and sodium. Among the microelements, the concentration of boron was noteworthy and, with the exception of that of iron, exceeded the remainder of the minerals in this group. On the other hand, manganese presented the lowest content in the banana studied here.

In general, the mean concentrations of Na, K and P found by us, in the banana cultivated in Tenerife, were

Table 5
Summary of the mineral content differences of macroelements and microelements between the different areas of origin of the banana samples[a]

	Origin
Macroelements	
Sodium	North = South
Potassium	North > South
Calcium	South > North
Magnesium	North > South
Phosphorus	North > South
Overall	North > South
Microelements	
Iron	North > South
Copper	North > South
Zinc	North > South
Manganese	North = South
Boron	North > South
Overall	North > South

[a] 1MANOVA: (of Wilks) = 0.56, with $F(5.144) = 17.8$, $P < 0.001$. 2MANOVA: (of Wilks) = 0.67, with $F(5.144) = 11.3$, $P < 0.001$.

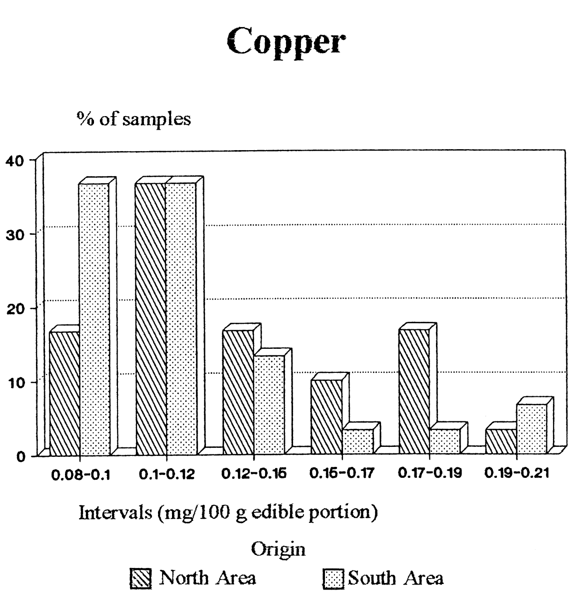

Fig. 8.

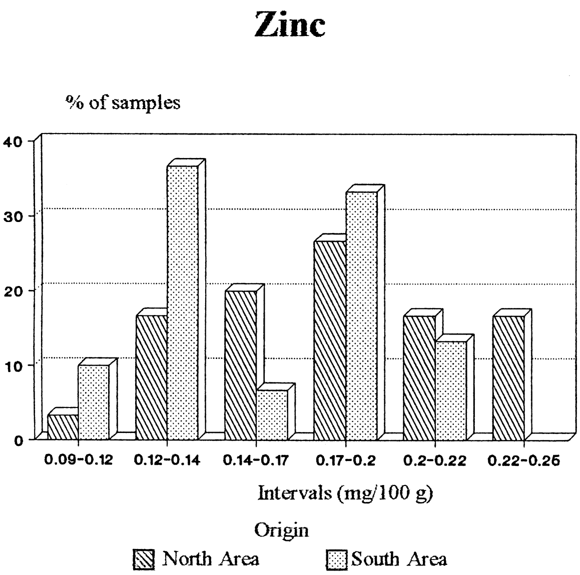

Fig. 9.

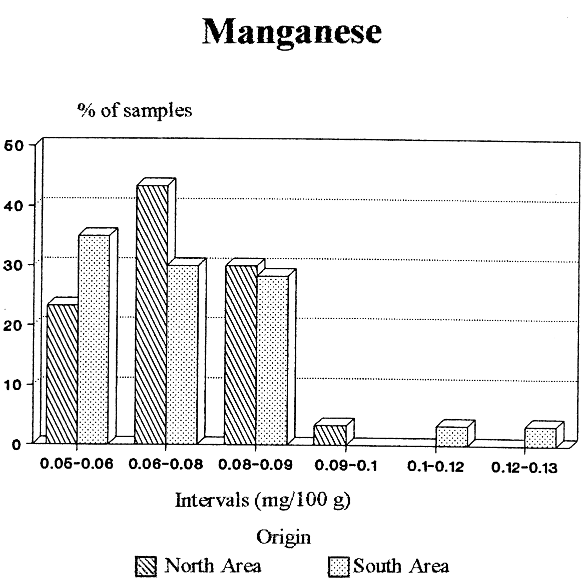

Fig. 10.

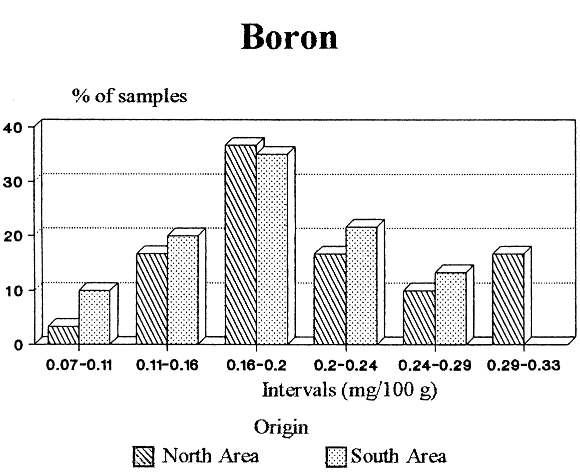

Fig. 11.

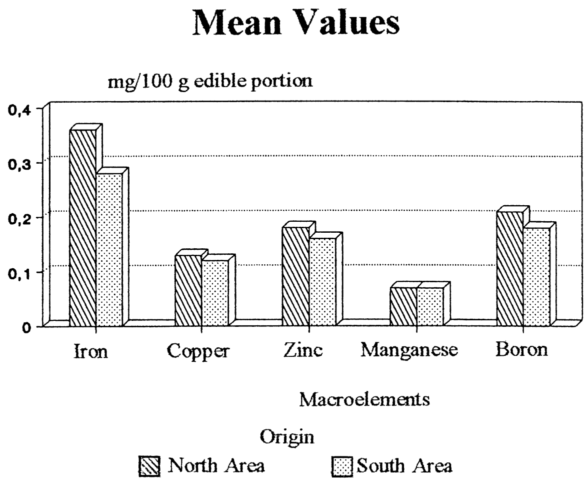

Fig. 12.

greater than those reported in the literature consulted (Table 6), while the mean values corresponding to the five microelements tended to be lower (Chauhan et al., 1990; Ellen et al., 1990; Ferguson et al., 1989; Gates & Lehmann, 1968; Jorhem et al., 1993; Kodia et al., 1979; Monro et al., 1986; Sánchez-Castillo et al., 1998; Tahvonen, 1993; Wills et al., 1986). This behaviour remained constant for the entire batches of analysed samples, and for both sampling areas under study.

A comparison of the results obtained by us with those presented in different food composition tables (Table 7) revealed a similar situation to that described above (Andújar, Moreiras Varela & Gil, 1990; Elmadfa, 1991; Feinberg, Favier & Ireland Ripert, 1991; Jiménez, Cervera & Bacardi, 1997; Mataix, 1993; Ministerio de Agricultura Pesca y Alimentación, 1991; Moreiras, Carbajal

Table 6
Summary of the published mineral content of the banana in the literature. Comparison with the results obtained in this study

Reference	Origin	Species, variety	Macroelements (mg/100 g)				
			Na	K	Ca	Mg	P
Gates and Lehmann, 1968			0.17–0.31	373–399	2.0–3.3	21.8–32.9	3.8–18.0
Kodia et al., 1979	Costa Márfil	*M. sapientum*	3.00	382	12.0	35.0	30.0
Kodia et al., 1979	Camerún	*M. sapientum*	4.00	323	14.0	37.0	32.0
Kodia at al., 1979	Costa Márfil	*M. paradisiaca*	5.00	435	25.0	38.0	43.0
Kodia at al., 1979	Guadalupe	*M. paradisisca*	4.70	432	22.0	40.0	42.0
Monro et al., 1986	Tonga		0.70	391	4.00	44.0	30.0
Wills et al., 1986	Australia	*M. acuminata*, var. Cavendish	1.00	350	5.00	19.0	–
Ferguson et al., 1989	Malawi	*M. paradisisca*	3.00	–	9.00	–	26.0
Ferguson et al., 1989	Papúa N. Guinea	M. spp	–	–	7.00	36.0	27.0
Chauhan et al., 1991	India	Banana c.v. Harichal (unripe)	Low	137	< 10	18	18
Chauhan et al., 1991	India	Banana c.v. Harichal (ripe)	Low	143	< 10	14	13
Tahvonen, 1993			–	370	50.0	3.0	–
Sánchez-Castillo et al., 1998	Mexico	*M. paradisiaca*	16	637	4	64	44
Interval			0.17–5.00	323–435	2.00–50.0	19.0–44.0–	13.5–43.0
This study	Tenerife	*M. acuminata*, var. Cavendish	11.7	509	18.8	37.7	59.1
This study	North Tenerife	*M. acuminata*, var. Cavendish	12.0	534	17.9	41.2	63.4
This study	South Tenerife	*M. acuminata*, var. Cavendish	11.4	483	19.9	33.6	54.7
			Microelements (mg/100 g)				
			Fe	Cu	Zn	Mn	B
Gates and Lehmann, 1968			1.33–2.16	0.07–0.09	–	0.06–0.34	0.07–0.1
Kodia et al., 1979	Costa Márfil	*M. sapientum*	0.70	0.22	–	0.66	–
Kodia et al., 1979	Camerún	*M. sapientum*	0.80	0.25	–	0.70	–
Kodia et al., 1979	Costa Márfil	*M. paradisiaca*	0.90	0.27	–	1.40	–
Kodia et al., 1979	Guadalupe	*M. paradisiaca*	0.90	0.30	–	1.30	–
Monro et al., 1986	Tonga		0.44	0.21	0.25	0.55	0.53
Wills et al., 1956	Australia	*M. acuminata*, var. Cavendish	0.50		0.20	–	–
Ferguson et al., 1989	Malawi	*M. paradisiaca*	–	–	0.20	0.74	–
Ferguson at al., 1989	Papúa N. Guinea	M. app	–	0.13	0.25	0.15	–
Ellen at al., 1990			–	0.09	0.15	0.27	–
Chauhan et al., 1991	India	Banana c.v. Harichal (unripe)	0.37	0.10	0.21	–	0.09
Chauhan et al., 1991	India	Banana c.v. Harichal (ripe)	0.50	0.09	0.17	–	0.07
Jorhem et al., 1993			–	0.09	0.15	0.17	–
Tahvonen, 1993			–	0.16	0.19	–	–
Sánchez-Castillo et al., 1998	México	*M. paradisiaca*	2	0.40	0.34	0.26	–
Interval			0.34–0.90	0.07–0.40	0.15–0.34	0.06–1.40	0.07–0.53
This study, all samples	Tenerife	*M. acuminata* var. Cavendish	0.31	0.13	0.17	0.07	0.20
This study	North Tenerife	*M. acuminata* var. Cavendish	0.36	0.13	0.18	0.07	0.21
This study	South Tenerife	*M. acuminata* var. Cavendish	0.28	0.12	0.16	0.07	0.18

Table 7
Comparison of the mineral content results obtained in this work and those included in some tables of food composition (mg/100 g of edible portion)

Reference	Macroelements					Microelements				
	Na	K	Ca	Mg	P	Fe	Cu	Zn	Mn	B
Andújar et al., 1990			9.00	38.0		0.6		0.23		
Elmadfa, 1991	1.00	382	8.00	36.0	27.0	0.70				
MAPA 1991[a]	1.00	380	8.70	36.0	28.0	0.55		0.22		
Feinberg at al., 1991	1.00	380	9.00	35.0	28.0	0.40				
Jiménez et al., 1997	3.00	380	11	35.0	28.0	0.60	0.104	0.23		
Moreiras et al., 1995	1.00	350	9.00	38.0		0.6		0.23		
Mataix, 1993	3.00	350	9.0	38.0	28.0	0.6		0.23		
Intervals	1.0–3.00	350–393	8.00–11.00	35.0–38.0	27.0–28.0	0.40–0.70	0.104	0.22–0.23		
This study: all samples	11.7	509	18.8	37.7	59.1	0.31	0.13	0.17	0.07	0.20
This study North area	12.0	534	17.9	41.2	63.4	0.36	0.13	0.18	0.07	0.21
This study South area	11.4	483	19.9	33.6	54.7	0.28	0.12	0.16	0.07	0.18

[a] MAPA, Ministerio de Agricultura, Pesca y Alimentación.

Table 8
Contribution of the consumption of a banana piece (75 g) to the daily requirements of major and minor elements

	Contribution to the EDR (%)[a]		
	Children (6 months–1 year)	Children (6 months–10 years)	Adults (> 10 years)
Macroelements			
Na	0.88–0.29	0.88–0.29	0.35
K	12.7–9.5	12.7–9.5	12.7–9.5
Ca	2.36	2.18	2.36–1.67
Mg	33.1	22.5–11.2	9.37–7.03
P	5.54	5.54	3.69–5.54
Microelements			
Fe	3.16–2.46	2.2–1.23	2.2–1.23
Cu	15.6–13.4	9.38–4.69	6.25–3.12
Zn	2.55	1.28	0.85
Mn	8.75–5.25	5.25–1.75	3.5–2.10
B		14.63	

[a] EDR, estimated daily requirements.

& Cabrera, 1995). The contents of sodium, calcium and phosphorus are between two and ten times higher; and the values found for magnesium in the samples from the north are greater than those from the south, the mean value of all the samples falling within the range of concentrations of samples of bananas from Tenerife. The content of iron was lower than those presented in the above-mentioned tables; no data have been found for the remainder of the minor elements, with the exception of zinc, the values of which were somewhat lower in the samples from Tenerife.

Finally, the banana clearly contributes to the estimated daily requirements of K, Mg, Cu and B (Table 8).

4. Conclusions

The results presented here have demonstrated the existence of significant differences according to the area of origin of the analyzed bananas (north vs. south, of the Island of Tenerife), in both groups of mineral elements, the values observed being greater in the fruit from the north of the island.

Likewise, significant differences have also been detected in the levels of concentration of all the studied elements, with the exception of sodium and manganese. Thus, the banana samples from the north present significantly higher concentrations of potassium, magnesium, phosphorus, iron, copper, zinc and boron, while the content of calcium is greater in the samples from the south area of Tenerife.

On the other hand, when comparing these results with those obtained by other authors, the mean concentrations of sodium, potassium and. phosphorus are, in general, greater than those published in the bibliography consulted, while the mean values corresponding to the five minor elements tend to be lower.

A comparison of the results obtained by us with those found in different food composition tables reveals a trend similar to that described above: the contents in sodium, calcium and phosphorus are greater in the samples of bananas from Tenerife; however, for magnesium, the values of the samples from the north are higher, the average for all samples fatling within the range of concentrations presented in these tables; the content of iron is found to be lower than those presented in the same charts, which do not show the data for the remaining minor elements, with the exception of zinc, the values for which are somewhat lower in the samples from Tenerife.

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