Composition of Different Bean Varieties (*Phaseolus vulgaris*) of Northwestern Argentina (Region NOA): Cultivation Zone Influence

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There have been prior investigations concerning the environmental effects and especially soil conditions upon the proximate analysis and mineral content of grains. However, the studies are not complete and have not involved beans grown in the northwestern regions of Argentina. For this reason, this study was initiated to determine the concentration of protein, moisture, ash, fat, and minerals of various bean samples grown in northwestern Argentina. Six varieties of beans were taken from seven different regions. AOAC standard methods were used for chemical analysis. The elements analyzed for all bean samples show that moisture varies from 12 to 14%, proteins from 18 to 22%, fat from 0.7 to 1.20%, copper from 0.8 to 1.20 mg/100 g, iron from 9 to 18 mg/100 g, zinc from 2.5 to 4 mg/100 g, and phosphorus from 295 to 542 mg/100 g. No arsenic was detected in the bean samples. Different analyzed bean varieties were significantly different for proximate composition and mineral content, and each variety from different regions of northwestern Argentina present significant differences.

Keywords: *Beans; chemical composition; mineral content; cultivation zone*

INTRODUCTION

Economically, the bean is one of the most important cultivation resources of the Argentine northwest (NOA). The white bean ranks highest in importance and is followed by the black bean.

Jujuy (a province of northwestern Argentina) produces ~22300 tonnes of white beans, 13900 tonnes of black beans, and nearly 4200 tonnes of other varieties per year, including the red bean, the carioca, the small red, the oval, and others.

In Argentina, however, there is not a high consumption of beans. Argentina differs from other Latin American countries, such as Brazil, where bean consumption per capita is 19 kg/year, or Mexico, with 16.1 kg/year. The same holds true for Nicaragua, with 20.5 kg/year. The worldwide average bean consumption per capita is 2.9 kg/year. In contrast, the Latin American per capita consumption is 11.9 kg/year on average.

In the past 30 years, the bean industry has gone through a period of notable growth, which has been sustained by the exportation market. Ninety percent of the country's production is destined for external markets. Exportation of the Alubia variety, mainly within the European market, and also of black beans to Latin America has contributed to an annual average income of $80 million. However, during the past 3 years, some important markets have been lost due to decreased production and also because of the industry's fundamental lack of knowledge of commercial supply and demand. The industry has no historic data to aid them in setting limits on production. Because there are no fixed limits, surpluses are produced, leading to a fall in prices.

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The traditional markets of the Argentine bean can be divided in two groups. The first one is composed of European countries, which have a high acquisitive power and demand products of high quality (Spain is the primary market followed by France and Italy). Europeans have increased their consumption of beans due to nutritionists' claims that beans have a high fiber content and that they may play a role in preventing heart disease, diabetes, and others diseases.

The second group is constituted by the Latin American countries, for which a high level of productivity is required because their populations consume a large quantity of beans for their protein content and because beans represent an inexpensive nutrition source.

The contents of some nutrients in foods, minerals for example, can vary largely depending on environmental factors such as soil composition (Fennema, 1993).

Various laboratories have studied the effects of soil upon mineral concentration of plants from different regions. There exist antecedents of correlation between the concentration of sulfates in the soil with the accumulation of selenium in the plants with the purpose of determining if some species could be cultivated in those polluted soils (Lin Wu et al., 1994).

The compositions of tropical fruits from different regions of Brazil have been studied to determine the relationship between cultivation zone and carotenoid concentration for various varieties of mango, papaya, and guava (Cavalcante and Rodriguez Amaya, 1995).

There have been prior investigations concerning the effects of the environment and especially soil conditions on the proximate analysis and mineral content of grains. However, the studies are not complete and have not involved beans grown in the northwestern regions of Argentina. For this reason, this study was initiated to determine the concentrations of protein, moisture, ash,

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Table 1. Bean Varieties of the NOA Region

variety	research zone	variety	research zone
Alubia	Rosario de La Frontera (RF)	Carioca	Perico
	Güemes (G)		Zona Norte (Pichanal-Orán)
	Valle de Lerma (VL)	red	Zona Norte (Pichanal-Orán)
	Pichanal (P)		Las Lajitas (L)
	Mezcla (M)	Grand Berry	Perico
black	Perico (Pe)		Pichanal
	Zona Norte (ZN) (Pichanal-Orán)	Great Northern	Perico
	El Carmen (C)		El Carmen

fat, and minerals of various bean samples grown in northwestern Argentina.

MATERIALS AND METHODS

Bean samples were obtained from various sources and locations (Table 1). The following three companies supplied the analyzed bean samples: Bergerco S.A. (B); Macina (M); and the Tobacco Cooperative (CT).

Obtained from Bergerco S.A. were Alubia variety, 3 kg; black variety, 3 kg; and other varieties, 1 kg.

One kilogram of each studied variety was obtained from the Tobacco Cooperative and Macina.

Bean samples were collected from both stored beans and beans currently being processed. The extracted volumes used were in proportion to the variety of amounts grown and to the zones where they were produced. It was estimated that 2 months had elapsed from the harvest date to when the samples were collected.

The samples collected according to the above protocol were stored in thermally sealed, double polyethylene bags until analyzed.

The bean samples were first processed in a disk mill, which split the bean. They were then ground in a coffee grinder, using a no. 14 screen to produce a final size of 1.19 mm. The ground samples were divided into fourths, and duplicates were taken for analysis.

The following analyses were carried out:

Moisture. Ground bean samples were placed in a drying oven at 105 °C until a constant weight was obtained, using AOAC (1995) method 935.29 or 27.3.06.

Protein was determined using the macro-Kjeldahl method with a sodium sulfate catalyst. The catalyst consisted of sulfate of copper pentahydrate and selenium in a 10:1 ratio, using AOAC (1995 method 991.20 or 33.2.11. The ground bean sample (~0.500 ± 0.001 g) was put into a Kjeldahl flask, and then 2.5 g of catalyst mixture and 10 mL of sulfuric acid were added. The sample was digested until white smoke developed and the digestive substance was clear. The process took ~4 h. After the digestive substance cooled to room temperature, it was transferred to a 100 mL volumetric flask and diluted with distilled water. Aliquots of 10 mL were put in a distillation unit, water and 8 mL of 50% NaOH were added, and the mixture was heated until all NH_3 had been distilled. The substance was poured into a 250 mL Erlenmeyer flask with 10 ± 0.1 mL of 4% H_3BO_3.

The distillate was titrated with 0.05 N sulfuric acid with trace metal red and bromocresol green indicator solution.

Total fat was analyzed by Soxhlet, using petroleum ether (30−60 °C) of reagent grade, using AOAC (1995) method 920.39 or 4.5.01. Dry ground bean samples (10 ± 0.001 g) were used.

Ash. The extracted oil samples were used for this determination. Bean samples were ashed in a muffle furnace at 550 °C, until a white ash was obtained, using AOAC (1995) method 968.08 or 4.8.02 (D). The ash samples were dissolved with both 6 and 3 N nitric acid. They were transferred to a 100 mL volumetric flask and diluted with bidistilled water.

Minerals were determined by atomic absorption spectrophotometry (Metrolab 250 AA), AOAC (1995) method 965.09 or 2.6.01, for copper (wavelength = 3247 nm, sensibility = 0.040 ppm), iron (wavelength = 2483 nm, sensibility = 0.062 ppm), zinc (wavelength = 2139 nm, sensibility = 0.009 ppm), and arsenic (wavelength = 1937 nm, sensibility = 0.78 ppm).

Table 2. Soil Analysis of the Güemes Region

	depth (cm)			
	0−13	13−37	37−64	64−110
pH	5.9	6.8	8.0	7.9
% CO_3Ca	0	0	1.5	1.58
% CO_3^{2-} organic	2.73	0.87	0.49	0.24
total nitrogen	0.23	0.09	0.06	0.05
C/N	11.9	9.0	8.2	5.2
exchange capacity	18.69	16.44	16.59	16.84
P available, ppm	56.00	47.25	25.62	8.72

Table 3. Soil Analysis of the Perico Region

	depth (cm)					
	0−14	14−33	33−50	50−69	69−86	86−130
pH	6.20	6.40	6.8	7.3	8.10	8.50
% CO_3Ca					3.41	2.89
% CO_3^{2-} organic	3.15	1.11	0.80	0.69	0.60	0.26
total nitrogen	0.252	0.093	0.075		0.061	0.033
C/N	12.5	11.9	10.7		9.8	7.9
exchange capacity	12.60	14.0	22.8	23.9	29.2	16.4

Table 4. Soil Analysis of the Las Lajitas Region

	depth (cm)				
	0−14	14−33	33−50	50−69	69−86
pH	6.20	6.40	6.80	7.30	8.10
% CO_3^{2-} organic	3.15	1.11	0.80	0.69	0.60
total nitrogen	0.252	0.093	0.075		0.061
C/N	12.5	11.9	10.7		9.8
exchange capacity	12.6	14.0	22.8	23.9	29.2

Phosphorus was determined according to a colorimetric method of Osborne and Vooght (1986), using a Hitachi U-2000 spectrophotometer (UV−vis). The reagents used were a standard of potassium phosphate, hydrochloric acid, and a mixture of ascorbic acid plus ammonium molybdenum for color.

All of the glassware was washed with 3 N nitric acid and then washed three times with bidistilled water.

Statistics. Data were analyzed using either analysis of variance or multiple analysis of ranges for measures using the test of minimal significant difference (or limits) (LSD) with a 95% level of significance.

RESULTS AND DISCUSSION

The data from the bean samples offer basic knowledge that can be used to establish national policies for bean utilization by the health industry, nutritionists, etc.

The Salta and Jujuy occupy some of the more common natural surroundings of the NOA region; the use of the soil is associated intimately with hydraulic resources, especially the three principal hydrographic basins of the Bermejo, Pilcomayo, and Juramento Rivers.

The determination of the soil composition (see Tables 2−6) of these three regions is necessary to understand the mineral composition found in the beans grown there (Tables 8−12).

Table 5. Soil Analysis of the Rosario de la Frontera Region

	depth (cm)		
	0−22	22−64	64−126
pH	7.00	7.30	8.10
% CO_3^{2-} organic	2.71	1.12	0.38
total nitrogen	0.19	0.10	0.06
C/N	14.26	11.20	6.33
exchange capacity	21.49	22.89	22.34

Table 6. Soil Analysis of the Zona Norte (Pichanal-Orán) Region

	depth (cm)	
	0−30	30−50
pH	6.7	6.9
% CO_3^{2-} organic	0.76	0.31
total nitrogen	0.054	0.027
C/N	14.1	11.15
exchange capacity	7.62	5.47

Pichanal, Güemes, and Rosario de la Frontera are part of the region called "Sierras Subandinas", which has a tropical mountain climate. The highest temperatures are registered during the summer season, in January, coinciding with the rains: T_{max} = 26.9 °C; T_{min} = 11.0 °C.

The atmospheric pressure and the relative humidity diminish toward the west, varying from 727 to 661.9 mmHg and from 77 to 6.8%, respectively.

The largest bean production area corresponds to the "Llanura Chaco Salteña", which has both a tropical climate and a dry season. The highest temperatures occur in January, with a mean temperature of 29.1 °C. The mean maximal oscillated from 27 to 30 °C, with the minimal winter temperature ranging from 12 to 16 °C. This region has large seasonal changes in temperatures. The atmospheric pressure is 749.0 mmHg, which is due to the increased elevation from the sea. The annual rainfall values range from 500 to 800 mm, with a pattern of decreasing rainfall toward the west but increasing rainfall toward the highlands. Due to intense evaporation and the added reduction in precipitation, a deficit of water has resulted in this region.

Other food sources grown in this area are soybeans, sorghum, and peanuts.

Alubia Bean. Significant differences in moisture content were found in the bean samples taken from the various regions. The greatest variation is present between the samples from Guemes and Valle de Lerma and could be due to the large difference in relative humidity between the zones.

The protein content in the samples from Rosario de La Frontera is larger than that in beans from Guemes, Pichanal, and Valle de Lerma, and this is due to the greater proportion of available nitrogen in the soil. The total mineral content is statistically similar in all bean samples, which reflects the mineral concentrations found in the soil.

Except for the sample of Valle de Lerma that shows 2.8 mg/100 g arsenic in its composition, all of the others have no detectable arsenic present.

Black Bean. Black bean samples analyzed from different regions are statistically different (Table 8). The samples with the higher moisture content correspond to the zone named Los Pericos, which had a higher relative humidity than the others. Part of the reason for the higher moisture content in the beans could be

Table 7. Alubia Bean: Proximate Composition and Mineral Concentration by Zones of Production[a]

source zone	moisture (%)	proteins (%)	fat (%)	ashes (%)	Cu (mg/100 g)	Fe (mg/100 g)	Zn (mg/100 g)	As (mg/100 g)	P (mg/100 g)
Rosario de la Frontera (B)	12.87 (a) ± 0.00	23.67 (b) ± 1.49	0.92 (a) ± 0.04	3.46 (bc) ± 0.02	0.95 (ab) ± 0.04	14.95 (bc) ± 0.57	2.12 (a) ± 0.04	ND (a)	429 (a) ± 18
Güemes (M)	13.63 (a) ± 0.12	19.50 (c) ± 0.58	0.60 (a) ± 0.00	3.77 (a) ± 0.15	1.19 (bc) ± 0.42	11.69 (abc) ± 2.87	2.75 (ab) ± 0.719	ND (a)	537 (a) ± 27
ZN-M94 (B)	11.91 (a) ± 0.00	19.04 (a) ± 0.18	0.56 (a) ± 0.08	3.90 (a) ± 0.02	1.08 (abc) ± 0.13	15.48 (c) ± 2.92	2.81 (ab) ± 0.719	ND (a)	529 (a) ± 51
ZN-MD (B)	12.20 (b) ± 0.00	18.55 (a) ± 0.65	0.55 (b) ± 0.04	4.29 (a) ± 0.26	1.32 (abc) ± 0.325	10.16 (ab) ± 1.31	2.48 (ab) ± 0.191	ND (a)	421 (a) ± 30
V. de Lerma	13.67 (c) ± 0.01	18.74 (c) ± 2.42	1.00 (bc) ± 0.00	4.04 (c) ± 0.25	1.81 (c) ± 0.00	9.01 (a) ± 0.00	2.93 (ab) ± 0.013	2.80 (b) ± 0.14	420 (a) ± 30
Pichanal (M)	11.86 (a) ± 0.32	19.09 (a) ± 0.12	0.90 (c) ± 0.00	4.39 (b) ± 0.00	0.82 (a) ± 0.40	7.18 (abc) ± 0.45	1.90 (b) ± 0.096	ND (a)	559 (a) ± 6
av ± SD	12.70 ± 0.85	19.76 ± 1.88	0.75 ± 0.21	3.97 ± 0.45	1.19 ± 0.35	11.41 ± 3.29	2.50 ± 0.41		468 ± 60

[a] Values in the same column, followed by the same letter, are statistically similar (95% of significance). ND, not detected. SD, standard deviation.

Table 8. Black Bean: Proximate Composition and Mineral Concentration by Zones of Production[a]

source zone	moisture (%)	proteins (%)	fat (%)	ashes (%)	Cu (mg/100 g)	Fe (mg/100 g)	Zn (mg/100 g)	As (mg/100 g)	P (mg/100 g)
Perico (CT)	12.45 (a) ± 0.58	24.02 (c) ± 0.05	0.71 (a) ± 0.03	3.81(ab) ± 0.04	1.36 (c) ± 0.00	17.91 (c) ± 2.12	6.18 (c) ± 0.58	ND (a)	372 (b) ± −0.71
Zona Norte (B)	13.12 (b) ± 0.05	19.2 (ab) ± 0.07	0.81 (a) ± 0.03	4.40 (d) ± 0.41	1.04 (b) ± 0.06	16.60 (c) ± 3.61	2.95 (ab) ± 0.314	ND (a)	382 (c) ± −10
El Carmen (B)	14.07 (c) ± 0.10	18.52 (a) ± 0.68	1.19 (b) ± 0.00	4.72 (e) ± 0.00	1.56 (d) ± 0.12	17.10 (bc) ± 2.20	2.88 (ab) ± 0.04	ND (a)	448 (e) ± −7
Zona Norte (B)	13.32 (b) ± 0.05	23.17 (c) ± 0.39	1.06 (b) ± 0.02	3.97 (c) ± 0.03	1.46 (cd) ± 0.10	13.35 (ab) ± 0.09	3.10 (ab) ± 0.10	ND (a)	533 (f) ± −6
Zona Norte (B)	11.99 (a) ± 0.21	18.61 (a) ± 0.90	1.33 (c) ± 0.12	3.93 (bc) ± 0.00	1.03 (b) ± 0.05	17.63 (c) ± 2.37	3.26 (b) ± 0.03	ND (a)	351 (a) ± −1.4
Pichanal (M)	12.49 (a) ± 0.04	19.85 (b) ± 0.02	0.80 (a) ± 0.04	3.72 (a) ± 0.07	0.85 (a) ± 0.07	12.80 (a) ± 0.28	2.72 (a) ± 0.03	ND (a)	423 (d) ± −0.71
av ± SD	12.91 ± 0.75	20.56 ± 1.73	0.98 ± 0.25	4.09 ± 0.39	1.22 ± 0.28	15.90 ± 2.24	3.52 ± 1.32		418 ± 66

[a] Values in the same column, followed by the same letter, are statistically similar (95% of significance). ND, not detected. SD, standard deviation.

Table 9. Grand Berry Bean: Proximate Composition and Mineral Concentration by Zones of Production[a]

source zone	moisture (%)	proteins (%)	fat (%)	ashes (%)	Cu (mg/100 g)	Fe (mg/100 g)	Zn (mg/100 g)	As (mg/100 g)	P (mg/100 g)
Perico (CT)	14.09 (a) ± 0.43	23.12 (a) ± 0.66	0.87 (a) ± 0.07	3.36 (a) ± 0.23	1.02 (a) ± 0.20	20.26 (b) ± 1.21	3.00 (a) ± 0.03	ND (a)	441 (a) ± 9
Pichanal (B)	12.64 (a) ± 0.26	19.87 (a) ± 0.48	1.09 (a) ± 0.05	4.22 (b) ± 0.24	0.97 (a) ± 0.03	15.14 (a) ± 0.13	3.29 (a) ± 0.03	ND (a)	439 (a) ± 9
av ± SD	13.37 ± 1.02	21.50 ± 2.30	0.98 ± 0.15	3.79 ± 0.61	0.99 ± 0.03	17.70 ± 3.62	3.15 ± 0.20		440 ± 1.41

[a] Values in the same column, followed by the same letter, are statistically similar (95% of significance). ND, not detected. SD, standard deviation.

Table 10. Red Bean: Proximate Composition and Mineral Concentration by Zones of Production[a]

source zone	moisture (%)	proteins (%)	fat (%)	ashes (%)	Cu (mg/100 g)	Fe (mg/100 g)	Zn (mg/100 g)	As (mg/100 g)	P (mg/100 g)
Zona Norte (B)	13.43 (b) ± 0.00	19.06 (a) ± 0.64	1.23 (b) ± 0.00	5.00 (b) ± 0.04	1.09 (a) ± 0.04	16.76 (b) ± 0.19	3.31 (a) ± 0.18	ND (a)	465 (a) ± 13
Las Lajitas (B)	12.91 (a) ± 0.04	20.20 (a) ± 0.61	1.21 (a) ± 0.00	4.92 (a) ± 0.01	1.03 (a) ± 0.07	10.75 (a) ± 0.11	3.97 (b) ± 0.20	ND (a)	619 (b) ± 27
av ± SD	13.17 ± 0.37	19.63 ± 0.81	1.22 ± 0.01	4.96 ± 0.06	1.06 ± 0.04	13.76 ± 4.25	3.64 ± 0.47		542 ± 109

[a] Values in the same column, followed by the same letter, are statistically similar (95% of significance). ND, not detected. SD, standard deviation.

Table 11. Carioca Bean: Proximate Composition and Mineral Concentration by Zones of Production[a]

source zone	moisture (%)	proteins (%)	fat (%)	ashes (%)	Cu (mg/100 g)	Fe (mg/100 g)	Zn (mg/100 g)	As (mg/100 g)	P (mg/100 g)
Perico (CT)	15.04 (b) ± 0.17	22.51 (b) ± 1.02	0.76 (a) ± 0.09	3.61 (a) ± 0.10	0.93 (a) ± 0.00	5.33 (a) ± 0.03	3.84 (c) ± 0.02	ND (a)	297 (a) ± 3
Zona Norte 1994 (B)	12.16 (a) ± 0.18	21.56 (b) ± 1.74	0.83 (a) ± 0.03	3.85 (b) ± 0.02	0.78 (a) ± 0.06	12.18 (b) ± 0.22	2.74 (b) ± 0.02	ND (a)	301 (a) ± 8
Zona Norte 1995 (B)	12.30 (a) ± 0.05	17.01 (a) ± 0.21	1.06 (b) ± 0.04	4.14 (c) ± 0.04	1.24 (b) ± 0.08	9.21 (ab) ± 0.15	2.38 (a) ± 0.01	ND (a)	286 (a) ± 10
av ± SD	13.17 ± 1.62	20.02 ± 2.79	0.88 ± 0.16	3.87 ± 0.27	0.98 ± 0.23	8.91 ± 3.44	2.99 ± 0.76		295 ± 8

[a] Values in the same column, followed by the same letter, are statistically similar (95% of significance). ND, not detected. SD, standard deviation.

Table 12. Great Northern Bean: Proximate Composition and Mineral Concentration by Zones of Production[a]

source zone	moisture (%)	proteins (%)	fat (%)	ashes (%)	Cu (mg/100 g)	Fe (mg/100 g)	Zn (mg/100 g)	As (mg/100 g)	P (mg/100 g)
Perico (CT)	12.98 (a) ± 0.33	23.15 (b) ± 0.03	0.54 (a) ± 0.00	4.83 (a) ± 0.01	0.80 (a) ± 0.01	7.08 (a) ± 0.04	3.95 (b) ± 0.01	ND (a)	439 (a) ± 3
El Carmen (B)	12.93 (a) ± 0.02	19.97 (a) ± 0.11	0.56 (a) ± 0.00	4.86 (a) ± 0.11	0.91 (ab) ± 0.06	10.11 (b) ± 0.22	3.79 (b) ± 0.01	ND (a)	485 (ab) ± 8
El Carmen (B)	13.38 (a) ± 0.29	21.41 (a) ± 0.65	0.51 (a) ± 0.05	4.93 (a) ± 0.17	1.16 (c) ± 0.00	12.23 (c) ± 0.08	3.40 (a) ± 0.04	ND (a)	490 (ab) ± 22
El Carmen (B)	12.85 (a) ± 0.13	20.29 (a) ± 0.57	0.55 (a) ± 0.05	4.94 (a) ± 0.05	1.05 (bc) ± 0.01	9.78 (b) ± 0.03	3.46 (a) ± 0.03	ND (a)	502 (b) ± 6
av ± SD	13.03 ± 0.24	21.20 ± 1.34	0.54 ± 0.02	4.89 ± 0.53	0.98 ± 0.23	8.91 ± 3.44	2.99 ± 0.76		295 ± 8

[a] Values in the same column, followed by the same letter, are statistically similar (95% of significance). ND, not detected. SD, standard deviation.

due to the lack of drying caused by the higher humidity in the air. No arsenic was found in the bean samples.

Grand Berry Bean. Moisture, protein, and total fat of bean samples from Perico and Picahanal were not significantly different (Table 9). However, the ash values were significantly different. Iron from Perico was significantly different, but the copper and zinc values were not.

Red Bean. The concentrations of proteins and copper were not significantly different between the bean samples from Las Lajitas and Zona Norte (Table 10). No arsenic was detected in bean samples from these regions.

Carioca Bean. Data obtained for the samples form Zona Norte, corresponding to crops from different years (1994−1995), had no significant differences for moisture, iron, or phosphorus (Table 11). Ash, copper, iron, and zinc had significant differences between the Zona Norte and Perico regions. No arsenic was detected in the bean samples.

Great Northern Bean. There were no significant differences in bean samples from the various collection zones for moisture, fat, ash, and minerals. There were significant differences in protein and iron (Table 12). No arsenic was found in any of the bean varieties grown in this region.

Comparison among Varieties in Each Zone. Bean varieties analyzed from El Carmen were significantly different in moisture, fat, and proteins. The ash values were statistically similar. No arsenic was detected in the bean samples from this zone.

Bean varieties from Zona Norte were significantly different for moisture, protein, ash, and mineral content, with the exception of copper. No arsenic was found in bean samples grown in this region.

Bean varieties from the Güemes region had significant differences in protein and fat, but not in moisture, ash, copper, iron, zinc, and phosphorus. No arsenic was detected in bean samples grown in this region.

Bean varieties from the Pichanal region had significant differences in ash, fat, iron, zinc, and phosphorus, whereas protein values were not significantly different. No arsenic was detected in bean samples grown in this region.

Bean varieties from the Perico region had significant differences in moisture, fat, ash, copper, iron, zinc, and phosphorus. Protein values were not significantly different. No arsenic was detected in bean samples grown in this region.

ABBREVIATIONS USED

NOA, northwestern region of Argentina; ZN, Zona Norte; P, Pichanal; P, Perico; C, El Carmen; L, Las Lajitas; B, Bergerco Co.; M, Macina Co.; CT, Tobacco Cooperative.

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