ABSTRACT
Four avocado powder samples were supplied. Three of them were proficiency samples with measured mean concentrations from profieciency testing at several different laboratories (« round robin ») of the following elements B, Ca, Cd, Cl, Co, Cu, Fe, K, Mg, Mn, Mo, Na, N, P, S and Zn. The fourth sample was an avocado (« check sample ») that was analyzed at Xenemetrix on X-Calibur.

OBJECTIVE
To perform a quantitative analysis on avocado powder, using three proficiency samples as calibration standards and to measure the concentrations of Na, Mg, P, S, Cl, K, Ca, Mn, Fe, Cu, Zn in the avocado powder check sample .

BACKGROUND
EDXRF is a fast and non-destructive technique that can quantify any type of sample solid, powder or liquid from within a few minutes and can be the method of choice. Energy Dispersive X-ray Fluorescence (EDXRF) spectrometers can play an important role in assuring that consistent quality of samples is retained throughout a manufacturing process.

ANALYTICAL CONFIGURATION
Table 1: Analytical Configuration

Instrument	X-Calibur EDXRF Bench top Spectrometer System
Anode	Rh-Anode X-ray Tube, 50W
Detector	High Resolution, high flux efficiency SDD detector
Analysis Time	300 second
Type of analysis	Regression analysis.
Sample Preparation	The avocado powder was prepared by customer.

EXPERIMENTALS
The three proficiency testing samples and the avocado check sample were provided as powder and were measured "as is" on X-Calibur. The shape, size and structure of the powder "particles" differed between the different samples, for example the green avocado powder was more "fine" than the fiber like powder of 2003-3-2.
The given concentration values (measured median) with standard deviation as received from the customer are listed in Table 2. Notice the units used: mg/kg (ppm) and mmol/kg. mmol/kg was converted to mg/kg (ppm) using the molecular weight of the element of interest.

Table 2: Given concentrations of the different components in the three "calibration standards.

Element	2003-3-2 Mean value ± std	2003-3-3 Mean value ± std	2003-4-1 Mean value ± std
B*	-	-	-
N*	-	-	-
Na (mmol/kg)	154±10	5.8±0.9	14.1±0.8
Mg (mmol/kg)	149.9±6	55.7±3	48.2±2
P (mmol/kg)	141.0±7	45.4±2	29.2±1
S (mmol/kg)	70.9±4	34.4±2	33.7±1
Cl (mmol/kg)	551.7±22	88.9±5	37.4±5
Ca (mmol/kg)	403.4±14	66.4±3	406±17
Mn (mg/kg)	89.5±5	182.6±9	616.0±31
Fe (mg/kg)	174.9±12	523.4±50	451.4±36
Co (mg/kg)	0.167±0.041	0.166±0.024	0.277±0.021
Cu (mg/kg)	4.3±0.4	11.2±0.7	8.7±0.4
Zn (mg/kg)	54.7±4	62.0±4	88.5±4
Mo(mg/kg)	0.389±0.070 (<mdl)	0.115±0.024 (<mdl)	0.234±0.041 (<mdl)
Cd (mg/kg)	0.128±0.008 (<mdl)	0.429±0.015 (<mdl)	0.203±0.019 (<mdl)

* Outside range of EDXRF

The three samples listed above were used as calibration standard. For each sample two spectra were acquired, one spectrum for the light elements and one spectrum for the other elements.

Boron and Nitrogen are outside the range of detectable elements in EDXRF and were not measured. Cd, Co and Mo in the ppb range were not detected in these samples. Minimum detection limits for Cd, Co and Mn in these types of samples are estimated in the range of 10's of ppm. All the other elements were detected and measured.
Calibration curves for all elements were established and the calibration data is presented in Table 3-6 and in Figures 1-11. Spectra of avocado check sample are shown in Figure 12 and 13. The avocado check sample was measured and quantified for all eleven elements using newly established calibration curves. The analytical report of the avocado check sample is presented in Table 7.

Table 3: Calibration data for Na, Mg and P

Sample ID	**Na** One-point calibration		**Mg** Stand. Dev=12, correlation=0.9970		**P** Stand. Dev=11, correlation=0.9975	
	Given ppm	Calculated ppm	Given ppm	Calculated ppm	Given ppm	Calculated ppm
2003-32	3542	3473	3643	3610	4367	4336
2003-33	133	ND	1354	1526	1406	1551
2003-41	324	ND	1171	1031	904	790

Table 4: Calibration data for S, Cl and K

Sample ID	**S** Stand.dev=5, correlation=1.0000		**Cl** Stand.dev=1042, correlation=0.9987		**K** Stand.dev=1330, correlation=1.0000	
	Given ppm	Calculated ppm	Given ppm	Calculated ppm	Given ppm	Calculated ppm
2003-32	2273	2272	19559	19088	52756	53068
2003-33	1103	1109	3153	4703	8949	7321
2003-41	1081	1077	1326	2123	4508	2908

Table 5: Calibration data for Ca, Mn and Fe

Sample ID	**Ca** Stand.dev=14, correlation=1.0000		**Mn** Stand.dev=1, correlation=1.0000		Fe Stand.dev=30, correlation=0.9862	
	Given ppm	Calculated ppm	Given ppm	Calculated ppm	**Given** ppm	Calculated ppm
2003-32	16167	16164	89	87	175	146
2003-33	2661	2684	183	182	523	498
2003-41	16272	16271	616	617	451	485

Table 6: Calibration data for Cu and Zn

Sample ID	**Cu** Stand.dev=1, correlation=0.9976		**Zn** Stand.dev=3, correlation=0.9977	
	Given ppm	Calculated ppm	Given ppm	Calculated ppm
2003-32	4	4	55	50
2003-33	11	11	62	61
2003-41	9	9	89	92

Figure 1: Calculated concentration versus given concentration of Na

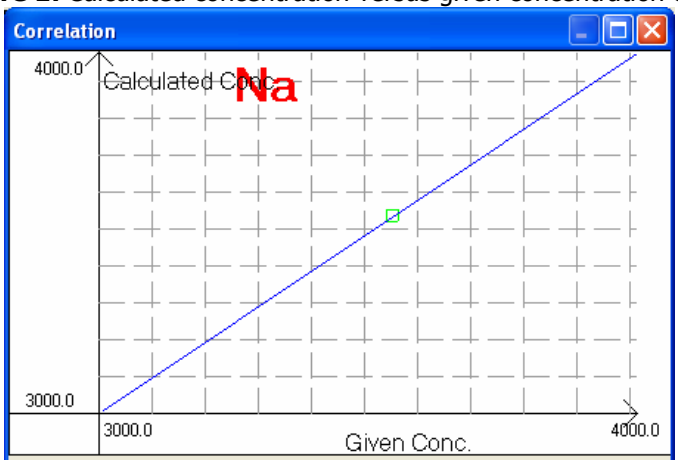


Figure 2: Calculated concentration versus given concentration of Mg

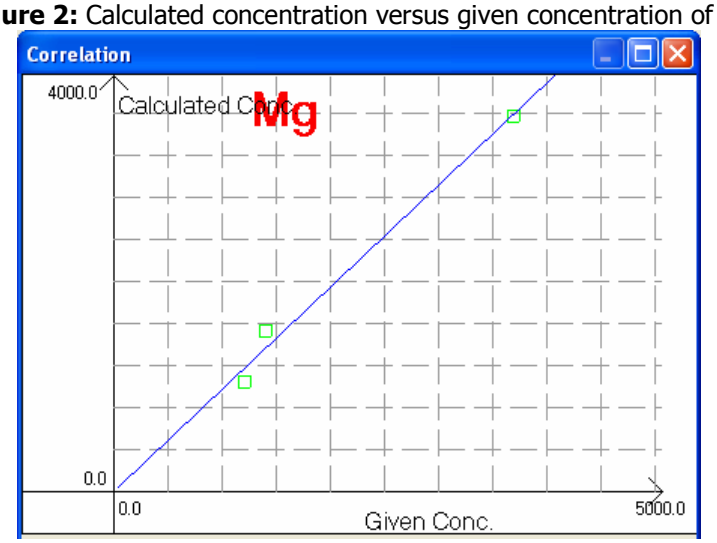


Figure 3: Calculated concentration versus given concentration of P

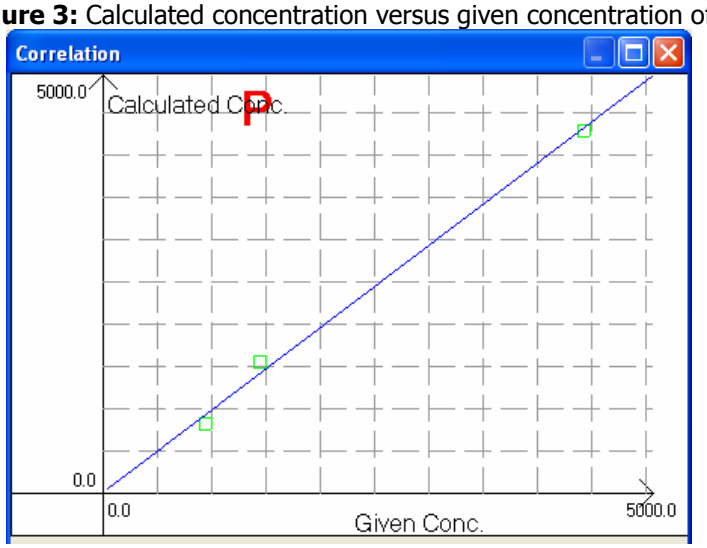


Figure 4: Calculated concentration versus given concentration of S

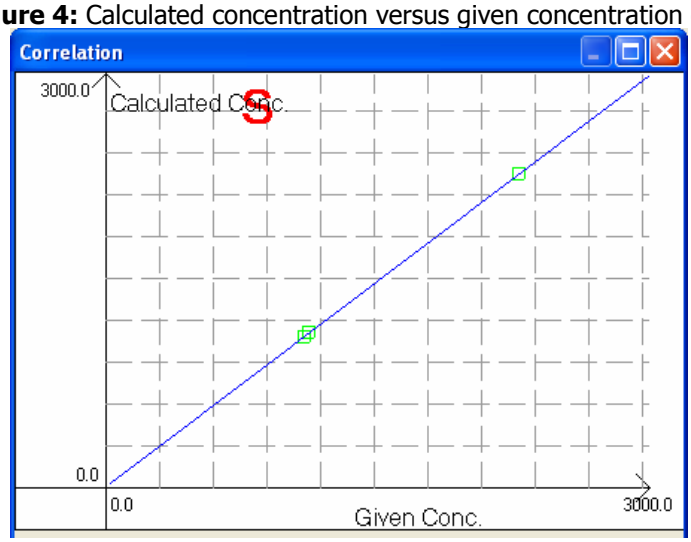


Figure 5: Calculated concentration versus given concentration of Cl

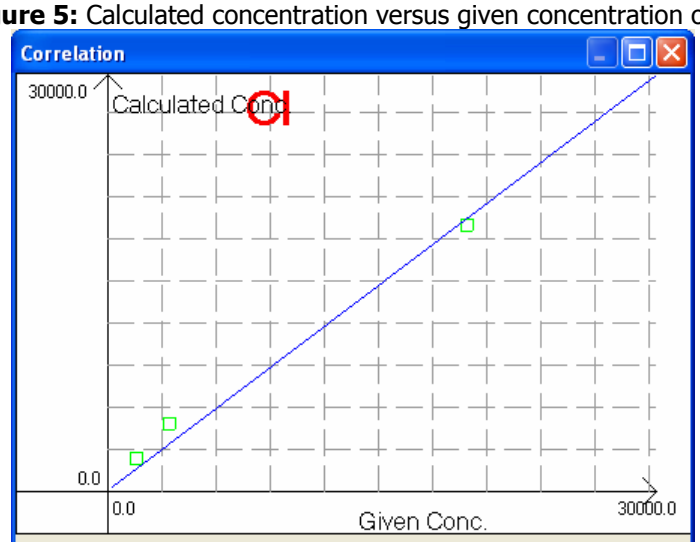


Figure 6: Calculated concentration versus given concentration of K

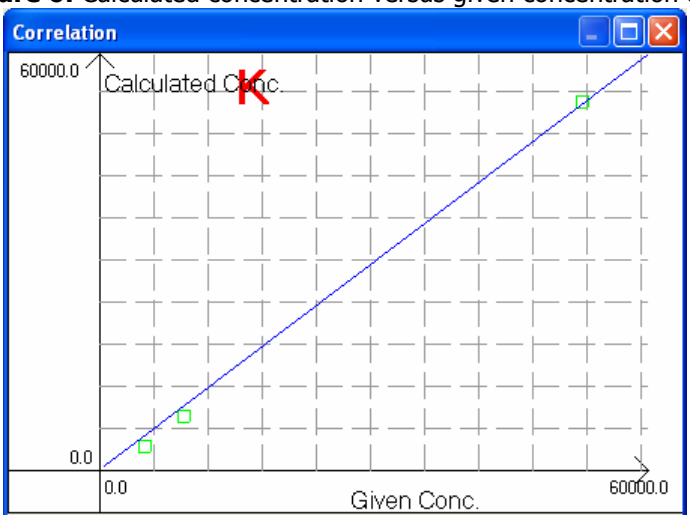


Figure 7: Calculated concentration versus given concentration of Ca

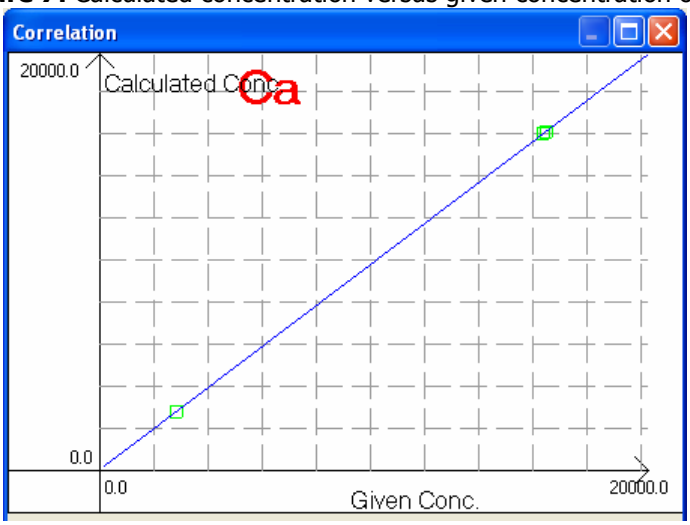


Figure 8: Calculated concentration versus given concentration of Mn

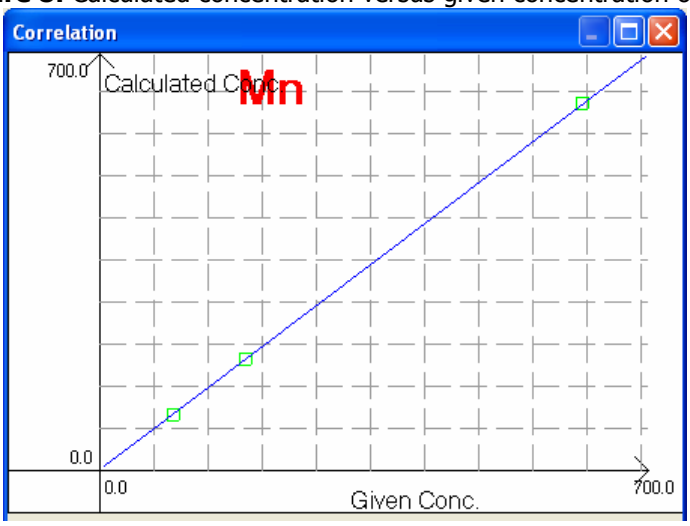


Figure 9: Calculated concentration versus given concentration of Fe

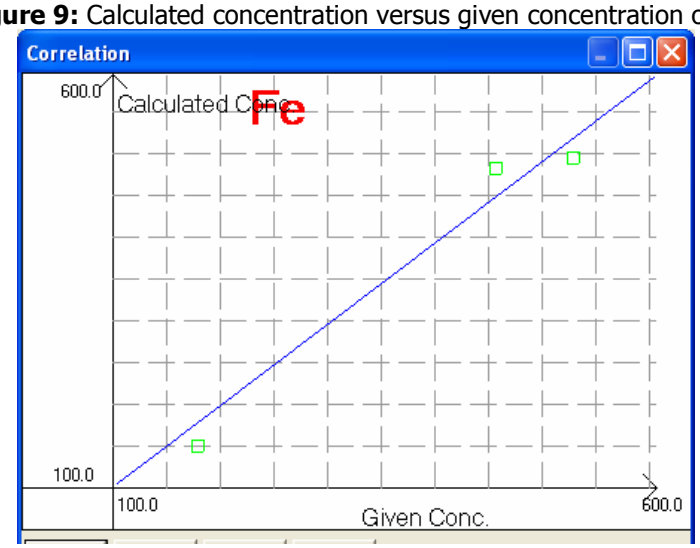


Figure 10: Calculated concentration versus given concentration of Cu

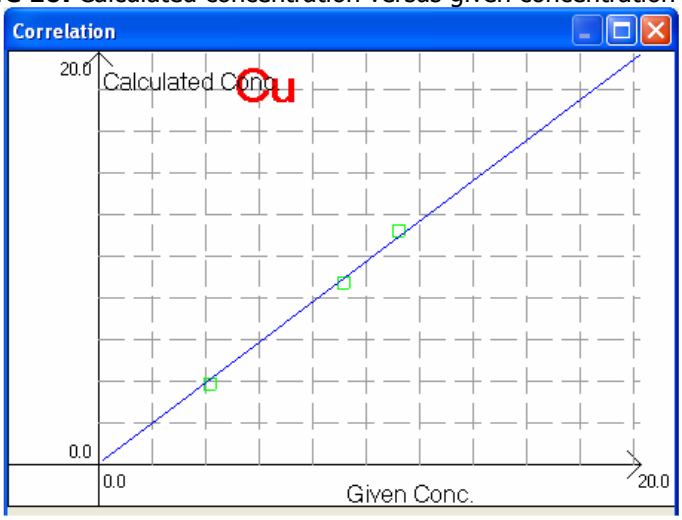


Figure 11: Calculated concentration versus given concentration of Zn

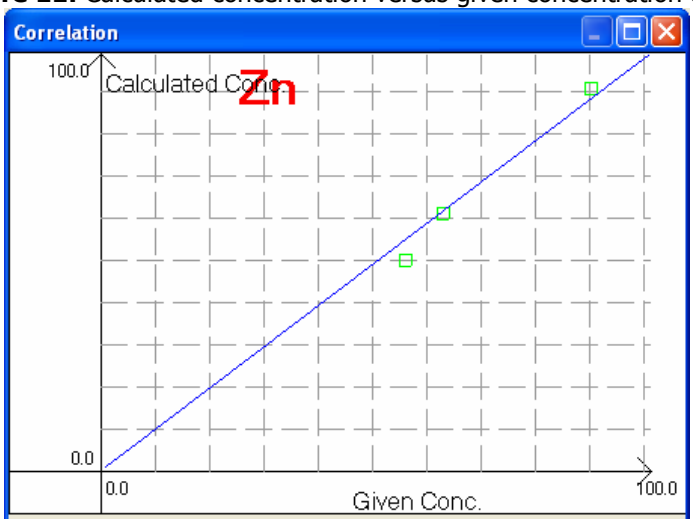


Figure 12: Spectrum of avocado powder for quantitative analysis of K, Ca, Mn, Fe, Cu and Zn

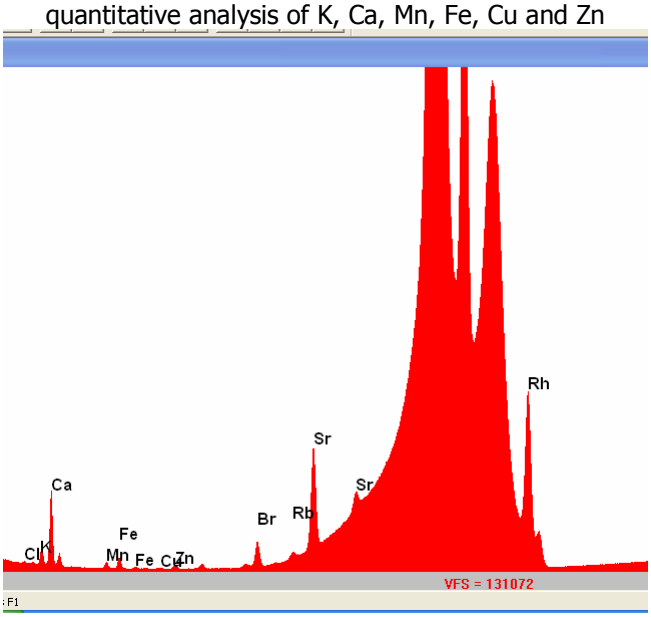
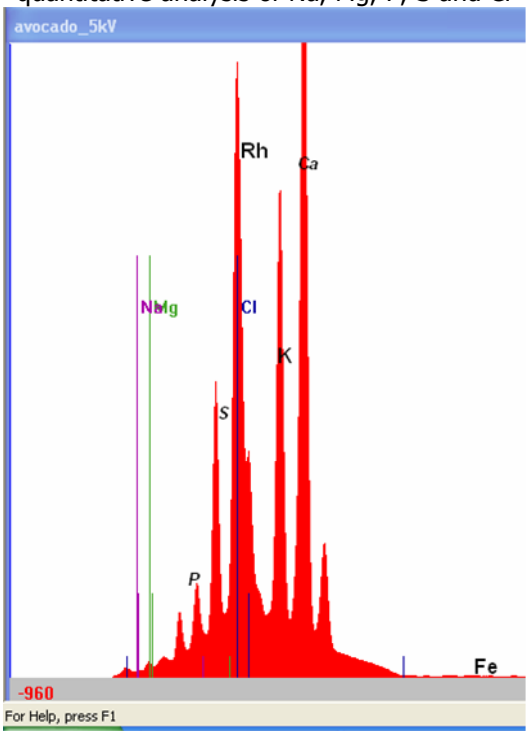


Figure 13: Spectrum of avocado powder for quantitative analysis of Na, Mg, P, S and Cl



RESULTS

The avocado powder was analyzed on X-Calibur using the calibration curves established.
The result is presented in Table 7. The result is also discussed in the discussion section below.

Table 7: Quantitative analysis on avocado powder

Element	Concentration ppm
Na	346
Mg	5555
P	1470
S	2788
Cl	6808
K	8831
Ca	23541
Mn	150
Fe	156
Cu	7
Zn	15

DISCUSSION

This report shows that avocado powder can be quantified in a quick and easy way using Xenemetrix EDXRF analyzer.
To improve the accuracy of the quantitative results of the eleven elements in the avocado powder it is strongly recommended to use more than three calibration standards. The need of more calibration standard is due to the inter-element effects that occur in XRF analysis. These inter-elements effects could not be properly processed in this application due to the too low number of calibration standards.

In addition, differences in powder structure and particle size also have an impact both on precision and on accuracy of the results. Further sample preparations such as grinding to same particle size (if possible), drying of samples and pressing powder into pellets will improve on the results.

Regarding the analysis of Na: the minimum detection limit as determined from sample 2003-32 is 136ppm at 1 sigma, i.e. the two samples 2003-33 and 20003-41 were excluded from the calibration curves and thus the Na calibration curve became "a one point calibration". To improve the reliability of Na analysis in this application it is recommended to add more samples with concentrations above 500ppm.