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Elemental analysis in the white cabbage in Gümüşhane, Turkey

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Abstract. The multi-elements in cabbages and the cabbage own soils are presented in this study. The cabbages were collected 21 different areas of Gümüşhane which is placed at the north-west of Blacksea region in Turkey. The elemental analyses of cabbages have been carried out using energy-dispersive X-ray fluorescence (EDXRF) spectrometry. Mean concentrations of the elements are presented and the metal contents were found in them which play a vital role in cure of disease. Ca and K contents in soils and in white cabbage were compared. They were found to be compatible with each other.

Keywords: Cabbage, Soil, EDXRF

1. INTRODUCTION

For 4000 years the benefits of cabbage have been known by many societies and accepted as an inevitable part of the cuisine. The Brassicaceae vegetables represent a major part of the human diet [1] being consumed by people all over the world [2-3] and are considered important food crops in China, Japan, India, and European countries [4-6]. As a culture-plant, white cabbages have grown particularly in the eastern Mediterranean countries. It was altered from the wild-mustard in Mediterranean [7]. It was considered as a medicine for curing some diseases by the ancient Greeks and Romans. Later, it was accepted as a culture vegetable and, many types of cabbage emerged such as the white cabbage in Figure 1. It has been variously called Brassica oleracea, red cabbage, rose cabbage etc. Red and white cabbages are grown in abundance in every region of Turkey. The annual consumption of cabbage in Turkey is 209 tons, this constitutes 6% of the Turkish agricultural product and represents 2% of the world production [8]. Even though, it has been known as a winter vegetable, the fact is that it is grown in every season of a year in Turkey and consumed by in varities of food and pickles in the cuisine.

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(a) (b)

Figure 1. a) The image of white cabbage, b) To measure at Skyray- EDXRF, pressed soil and white cabbage targets

The cabbage is not only a very delicious vegetable and rich food store it is also known to be a miracle herbal medicine. For these reasons Brassica oleracea is listed as one of the most interesting plants of the world [9]. Many studies have been examined to determine the trace elements in it. Bibak et al. found 63 elements in cabbage and sprouts which are grown in Denmark [10]. Trace elements were in Brassica oleraceae var. acephale which were collected from Giresun in Turkey by using Differential Pulse Polarography [12]

In some developing countries, societies rely heavily on traditional health producers and medicinal plants to cure their illness. Some plants which include beneficial minerals such as Mg, Ca, K, Fe, Zn etc have proven to be really effective for curing diseases. One of the recognised plants is white cabbage. It is not only rich in terms of Ca, P, K and Mg but also it is rich with regard to types of vitamins such as A, B1, B2, B3, B6, B12, C, K, U, pro-vitamin A (carotene), which are all profitable for human health. Particularly, vitamin U, which is only procurable in cabbage, is used to cure peptic ulcer [13-15].

Trace elements have important effects on life processes. Most of these elements are nontoxic for the humans even at a high level of intake. There has been considerable effort to determine the concentrations of trace elements in food and plant leaves by using the energy dispersive X-ray fluorescence technique (EDXRF). This technique is preferred in order to define various elements in the substance and to determine the characteristic features of such elements because it enables one to obtain more sensitive results. It is less time consuming, and economical. Additionally, analysis of samples with EDXRF technique is used in many areasj such as environmental pollution analysis, medicine, pharmacy, biochemical research, and quality control system and oil industry.

In this study, we carried out the element contents of the white cabbages and their own soils which were harvested from 21 different regions of Gümüşhane (a city west of the Black Sea region in Turkey). Our aim is to examine richness of the white cabbage grown in Gumushane in terms of the minerals which support human health.

2. MATERIAL and METHODS

White cabbages are called Brassica oleracea and their own soils were collected from 21 different stations of Gumushane. Stem tips, outer leaves, and damaged leaves were removed from the cabbage with a nitride-hardened titanium knife. All samples were prepared under laboratory controlled conditions, including the grinding method, grinding time, pelletized pressure and time. The white cabbages were dried at 70 °C in a Heraeus furnace. Both soils and cabbage samples were then grounded in a spex mill. To reduce particle size effects, the powder obtained was sieved by using a 400 mesh sieve and then it was stirred for 20 minutes to obtain a well-mixed sample. A five tone hydraulic press was used to compress the sample powder into a solid thick pellet of 40 mm diameter using a boric acide (H3BO3-powder) as a protective cover. The pellet target can be seen in Figure 1b.

The elemental concentration of the samples was determined using a Skyray EDX3600B spectrometer equipped with an Oxford Rh anode X-ray tube. The spectrometer has a SSD detector made in Germany which have 145 ±5 eV energy resolutions. This spectrometer is capable of 0.05% measurement precision, analytical range of elements from Sodium to Uranium, and ppm-99.99% analysis range. Besides, 24 elements can be analyzed simultaneously using it.

The standardization of the samples were made using Panalytical AXIOS Advanced WDXRF. In the work of the standardization IQ+ program was used. This program gives the semi-quantitative results with 95-90% precision for all materials. The standard curves were drawn at the EDX3600B spectrometer using the standard values which were obtained from the IQ+ program and uploaded to the system. The concentration of the samples was determined by the system using these standard curves.

3. RESULTS and DISCUSSION

Taken white cabbages and the soils from the growing regions of the white cabbage in Gümüşhane were analysed for their content of elements. In this manner, 21 stations from Gümüşhane were chosen. In the soils, 18 elements such as Na, Mg, Al, Si, P, S, K, Ca, Fe, Cu, Zn, Sr, V, Cr, Mn, As, Rb and Pb and in the white cabbages 11 elements such as Na, Mg, Al, Si, P, S, K, Ca, Fe, Sr and Mn were determined. According to the obtained datas, among the elements Ca and K contents were high levels both in the soils and the white cabbage samples. Table 1 and Table 2 show the percent content of the element in the cabbage and the soil samples, respectively. Furthermore, the comparison between the soils and the white cabbages can be seen in the Figure 1. Some previous studies claimed that Ca interferes with cholesterol absorption and metabolism by forming non-absorbable chalets with fatty acids and bile acids [16-20].

In addition to the benefits of mineral Ca, mineral potassium has an important role which is necessary for muscle contraction (specially cardiac fiber), for the synthesis of some proteins and as an enzymic cofactor metalloproteinase, chromo proteins, lipoproteins, etc. Therefore, the health benefits of cabbages are the following; being a natural antioxidant [21], preventing cancer [22-25], supporting cardiovascular system in the form of cholesterol reduction with its fibre content and providing with the cholesterol-lowering benefit whether it is raw or cooked. Today, epidemiological studies provide evidence that diets rich in cruciferous vegetables are associated with lower risks of several types of cancer, according to Oregon State University Cabbage in particular looks promising, boasting numerous cancer-preventing properties, including antioxidants and glucosinolates [26].

Furthermore, the cabbage could be recognised to provide people's cardiovascular system with valuable support in the form of cholesterol reduction. Researchers understand exactly how this process takes place. Human liver uses cholesterol as a basic building block to produce bile acids. Bile acids are specialized molecules that aid in the digestion and absorption of fat through a process called emulsification. These molecules are typically stored in fluid form in human gall bladder, and when eaten a fat-containing meal, they get released into the intestine where they help ready the fat for interaction with enzymes and eventual absorption up into the body. Turkish obesity prevention report defines obese population, referrs to the fight against nutritional advice, diet rich in fiber, vitamins and minerals support focused on the motion of life [27]. Supporting regional cabbage production will contribute greatly to our country in terms of both economic and health. When cabbage is eaten, fiber-related nutrients in this cruciferous vegetable bind together with some of bile acids in the intestine in such a way. They simply stay inside the intestine and pass out of your body in a bowel movement, rather than getting absorbed along with the fat they have emulsified. Moreover, a recent study has shown that the cholesterol-lowering ability of raw cabbage is improved significantly and would lower the risk of cardiovascular disease and cancer, advance human nutrition research, and improve public health when it is consumed regularly after steam cooking [28].

4. CONCLUSIONS

As a conclusion, the results obtained in this study suggest that white cabbage's external leaves may constitute a good source of health promoting elements such as Ca and K. EDXRF has been successfully used to detect trace elements in white cabbages samples. The comparison between all elements in all stations where the samples were collected can be seen in Figure 1. Found rich elements Ca and K are compared in point of concentration in Figure 2. These results may help to geographic and medicinal research investigating plants.

White Cabbage	**Element percent concentrations of the white cabbages**										
Stations in Gümüşhane	**Na%**	**Mg%**	**Al%**	**Si%**	**P%**	**S%**	**K%**	**Ca%**	**Fe%**	**Sr%**	**Mn%**
Akçahisar	0.0411	0.3905	0.2593	0.0110	0.1099	1.0725	3.0887	3.2880	0.0315	0.0071	0.0195
Akçakale	0.2182	1.0808	0.4032	0.0110	0.1851	1.5332	3.5016	3.7009	0.0310	0.0120	0.0211
Bahçelik	0.0448	0.7711	0.0529	0.1495	0.2555	1.0883	4.9500	7.9786	0.0349	0.0170	0.0078
Dibekli	0.0970	0.4699	0.0635	0.1822	0.2511	2.0682	2.7167	5.2929	0.0279	0.0085	0.0078
Eskişehir	0.2612	1.1265	0.0582	0.1822	0.3123	3.2008	5.0417	5.1786	0.0349	0.0000	0.0155
Geçit	0.2689	1.0344	0.3638	0.0110	0.1290	1.0083	3.2334	5.0976	0.0335	0.0099	0.0223
Gülaçar	0.1954	0.8920	0.3136	0.0110	0.1884	0.7630	2.6067	1.3526	0.0350	0.0000	0.0309
Güvercinlik Centrum	0.3838	0.8641	0.1725	0.0110	0.2490	0.5666	3.5783	4.7058	0.0350	0.0056	0.0233
Güvercinlik	0.0299	0.4759	0.1058	0.2477	0.2031	1.1486	3.8750	3.0541	0.0349	0.0000	0.0078
Hasköy	0.0111	0.3224	0.1779	0.4399	0.2119	0.9786	4.8666	4.0473	0.0343	0.0024	0.0237
Kale	0.2855	1.2325	0.2892	0.1679	0.1114	1.2940	2.1973	5.1536	0.0334	0.0125	0.0179
Karaçukur	0.3238	1.2975	0.2919	0.0110	0.1357	1.4632	1.9540	5.4703	0.0342	0.0000	0.0236
Kirazlı	0.3756	1.1056	0.2173	0.0110	0.1309	0.6550	2.0742	7.3951	0.0315	0.0296	0.0338
Kocadal	0.1685	1.2139	0.3910	0.0110	0.1580	0.9835	3.2615	8.0253	0.0315	0.0104	0.0112
Merkez	0.1194	0.8494	0.0635	0.2150	0.4694	2.6586	4.3001	4.8071	0.0349	0.0085	0.0078
Musalla	0.1591	0.6877	0.1603	0.1441	0.2362	0.7606	4.0897	1.0527	0.0349	0.0000	0.0242
Pirahmet	0.2907	0.7806	0.1535	0.0110	0.1929	0.8509	3.6075	1.2253	0.0342	0.0000	0.0328
Tekke	0.0235	0.5670	0.3218	0.0110	0.1084	1.1173	2.2231	1.7042	0.0361	0.0000	0.0260
Torul	0.1717	0.7169	0.0741	0.2337	0.3668	2.4578	2.3667	4.2429	0.0349	0.0085	0.2326
Yalınkavak	0.0970	0.2711	0.0899	0.2009	0.3494	0.9959	3.7083	1.6286	0.0419	0.0000	0.0078
Yeniyol	0.0746	0.4819	0.0582	0.1636	1.5582	3.1083	5.6214	3.1083	0.0279	0.0000	0.0078

Table 1. The data table shows that the concentration of elements in the cabbages

Soil samples	Element percent concentrations of the own cabbage soils																	
Stations in Gümüşhane	Na%	Mg%	Al%	Si%	P%	S%	K%	Ca%	Ti%	Fe%	Cu%	Zn%	Sr%	V%	Cr%	Mn%	As%	Rb%	Pb%
Akçahisar	3.590	1.547	11.50	52.59	1.037	0.008	2.273	15.55	0.422	3.046	0.000	0.013	0.033	0.000	0.008	0.032	0.000	0.005	0.000
Akçakale	3.311	2.689	15.54	56.10	0.426	0.051	2.278	7.114	0.691	6.050	0.013	0.018	0.025	0.006	0.009	0.084	0.001	0.006	0.003
Bahçecik	0.285	0.873	17.61	52.88	0.041	0.006	2.344	3.646	0.693	5.484	0.007	0.017	0.023	0.009	0.009	0.059	0.000	0.005	0.003
Dibekli	2.806	2.360	13.67	51.57	0.858	0.063	2.112	8.581	0.559	5.064	0.009	0.039	0.028	0.005	0.009	0.073	0.002	0.007	0.004
Eskişehir	1.041	3.173	11.04	41.73	1.202	0.055	2.055	15.58	0.439	4.167	0.019	0.068	0.012	0.003	0.005	0.159	0.013	0.006	0.196
Geçit	0.000	0.907	17.66	52.47	0.359	0.048	1.028	7.015	0.567	5.635	0.003	0.008	0.027	0.008	0.001	0.091	0.000	0.004	0.000
Gülaçar	5.244	2.533	8.774	35.66	1.873	0.005	1.556	29.99	0.342	2.235	0.000	0.012	0.027	0.000	0.009	0.057	0.000	0.004	0.000
Güvercinlik Centrum	2.974	1.625	17.19	54.33	0.758	0.060	2.516	7.029	0.599	4.769	0.016	0.023	0.019	0.002	0.006	0.104	0.002	0.006	0.001
Güvercinlik	7.429	3.433	13.75	55.10	0.997	0.082	2.566	4.850	0.595	5.730	0.026	0.025	0.029	0.007	0.010	0.086	0.002	0.007	0.005
Hasköy	3.030	1.444	15.59	50.91	1.012	0.009	3.699	7.049	0.603	4.321	0.006	0.019	0.025	0.002	0.009	0.084	0.001	0.012	0.010
Kale	2.134	2.646	13.15	49.49	0.497	0.006	1.296	11.08	0.679	6.789	0.013	0.013	0.028	0.004	0.009	0.067	0.000	0.003	0.000
Karaçukur	5.076	2.896	16.60	52.96	0.312	0.018	2.762	5.305	0.599	6.509	0.039	0.032	0.013	0.002	0.013	0.135	0.000	0.007	0.005
Kirazlı	1.966	1.565	13.72	49.32	0.548	0.008	1.974	15.72	0.526	4.631	0.000	0.012	0.020	0.000	0.011	0.160	0.002	0.006	0.004

Kocadal	5.188	2.395	15.41	48.47	1.200	0.096	3.850	3.091	0.849	7.991	0.009	0.029	0.010	0.015	0.008	0.144	0.002	0.003	0.005
Merkez	0.000	2.507	13.53	51.24	0.564	0.049	2.939	3.798	0.736	7.727	0.000	0.004	0.013	0.008	0.005	0.033	0.002	0.011	0.002
Musalla	4.151	3.069	12.15	54.06	0.348	0.037	2.819	4.411	0.707	6.152	0.009	0.015	0.012	0.004	0.009	0.062	0.002	0.009	0.001
Pirahmet	2.498	2.603	12.52	50.24	0.409	0.056	2.263	11.55	0.655	5.340	0.000	0.010	0.019	0.001	0.010	0.055	0.000	0.007	0.001
Tekke	1.657	2.326	13.52	52.34	0.186	0.030	2.001	6.662	0.631	5.693	0.003	0.009	0.026	0.004	0.008	0.070	0.000	0.006	0.000
Torul	2.470	3.026	16.53	55.69	0.159	0.058	2.770	2.333	0.673	5.955	0.013	0.011	0.019	0.012	0.004	0.135	0.002	0.009	0.008
Yalınkavak	2.414	2.032	15.45	51.52	0.550	0.015	1.585	4.103	0.584	7.256	0.018	0.025	0.026	0.011	0.009	0.074	0.000	0.006	0.011
Yeniyol	1.994	1.452	19.35	51.51	0.197	0.030	0.680	4.144	0.692	7.249	0.013	0.012	0.024	0.012	0.009	0.071	0.002	0.002	0.003

Table 2. The data table shows that the concentration of elements in the soils

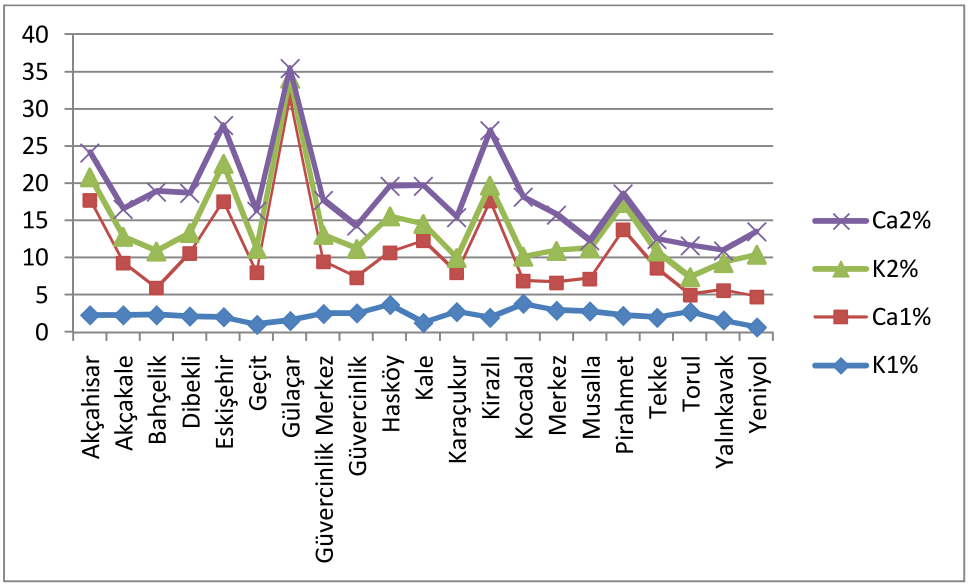

Figure 2. The graph shows that the comparison Ca and K elements concentrations in the cabbage and their own soils 1-White cabbages, 2- Soils

The protective role of Brassica vegetables in several types of cancer has proved. This protective effect is associated with the health-promoting phytochemical content in Brassica vegetables, which includes glucosinolates (GLS) and their breakdown products (isothiocyanates (ITC) and indoles) as well as antioxidants such as vitamin C and phenolic compounds. Cultivar, location, and growing conditions play important roles in the production of bioactive compounds in Brassicavegetables. The concentration and composition of GLS, phenolics, and vitamin C in Brassica vegetables is genotype dependent. Therefore, cultivar selection should be tailored to specific environmental factors at each location to achieve optimizationin phytochemical content of Brassica vegetables. In addition, selected white cabbages with an optimized bioactive compound content could be used as raw material for sauerkraut production, enhancing the human dietary intake in health promoting compounds. Penas et al. demonstrated that GLS values found in Spanish cabbage was rather lower than those observed in Turkish cabbages (50 and 70 μmol/g dm) and higher than those presented in cabbages from different European regions (3.3-7.7 μmol/g dm) [29]. This kind of investigation provides us information regarding the most suitable Turkish growing location to produce white cabbage with an optimized content of health-promoting compounds.

Breast cancer is the most common cancer among women and the leading cause of cancer mortality among women worldwide. Estrogens play an important role in breast cancer development acting as promoters and initiators of carcinogenesis process. Aromatase, a cytochrome P450 encoded by CYP19, is the enzyme that synthesizes estrogens by converting C19 androgens into aromatic C18 estrogenic steroids. Several studies have shown that there is a high expression of aromatase in breast cancer tissue [29]. Therefore, suppression of insitu estrogen formation, particularly in the breast of postmenopausal women by aromatase inhibitors (AIs) is considered as a useful way to prevent and treat breast cancer in these patients. Many epidemiological studies have shown that a diet high in fruits and vegetables can reduce breast cancer incidence. Epidemiological studies have also demonstrated that consumption of Brassica vegetables is associated with a lower incidence of cancers. This chemopreventive activity of cabbage against breast cancer observed in epidemiological studies may be partly explained by inhibition of the aromatase expression.

Phytoremediation, defined as the use of vegetation for insitu treatment of contaminated soils, sediments and water, is an environmental biotechnology. Now, Phytotechnologies term is used instead of the traditional term of phytoremediation. It is aimed by Phytotechnologies to promote sustainable land use management and improve food safety. Phytotechnologies are based upon the basic physiological mechanisms taking place in higher plants and associated microorganisms, such as transpiration, photosynthesis, metabolism, and mineral nutrition. Plants dig their roots in soils, sediments and water, and roots can take up organic compounds and inorganic substances; roots can stabilise and bind substances on their external surfaces, and when they interact with microorganisms in the rhizosphere. Uptaken substances may be transported, stored, converted, and accumulated in the different cells and tissues of the plant.

There have been investigated many studies on breast cancer. According to the researches the terms of Phytoremediation and biofumigation are defined taking the structure of plant residues in the soil and organic chemicals, and they are defined as clearing of soils. Chemicals in the soil are taken by plants and turned into poison for insects and parasites, thus becoming the natural agriculture drugs, especially the cabbage family in Africa, and in America the cabbage is used. Kusznierewicz et. al. claimed that the increased soil contamination by metals caused greater accumulation in cabbage and the results obtained pointed to the high phytoremediation and biofumigation potential of white cabbage [33]. This study group investigated the relationship between the ability to accumulate heavy metals (represented by Cd and Zn) and to synthesize bioactive compounds (represented by glucosinolates [GLS]) in two cabbage cultivars. The measurements of Cd and Zn contents in soil and cabbage (leaf) samples were performed by atomic absorption spectroscopy, whereas GLS levels in cabbage were determined by high-performance liquid chromatography. The ranges of metal contents in soil were 80 to 450 mg/kg dry weight for Zn and 0.3 to 30 mg/kg dry weight for Cd, whereas the levels of accumulated Zn and Cd in cabbage amounted to 15 to 130 and 0.02 to 3 mg/kg dry weight. In this study the contents of Zn is between 0,01% and 0,06 %. The datas showed that the soils in Gümüşhane are proper for agriculture, as it does not include high contamination. Although, the soil properties of Gümüşhane region were a mixture of comminute rock and organic matter, it supported ordinary land plants, and it doubtlessly contained a rich microbiota but the white cabbage does not need any requirement for growing in view of the soil. This kind of studies may help to follow the contamination of solids among the regions.

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