DETERMINATION OF THE CHEMICAL COMPOSITION OF USED COFFEE GROUNDS

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One of the world's most consumed beverage is coffee. Over 2.25 billion cups of coffee are prepared per day. It takes about 11 grams of fresh ground coffee to make one cup. As a result, 24750 tons of ground coffee becomes a waste. Most of used coffee grounds are thrown away as a general waste. Because of the moisture that comes within, grounds are starting to rot in a landfill. As a consequence, they emit a greenhouse gas – methane [1]. The growing awareness of environmental protection encourages to recycle and design new zero waste technologies. Dried coffee grounds are natural, not harmful to the environment resource, which can be applied in many other fields. For example dried coffee grounds can be used as a source of thermal energy, because of the calorific value (100 kg coffee grounds produce 4600 MJ) [2]. Moreover, spent coffee grounds can be used as bio-fuel, water filter or even as an abrasive [3, 4]. Literature sources claim that used coffee grounds are very beneficial for soil and plants in particular. It can be used as a mulch or even a fertilizer [5]. The main purpose of this thesis is to analyze chemical composition of spent coffee grounds and evaluate its application in fertilizers industry. Four types of well-known coffee brands were used in this research. Spent coffee grounds were processed with hot water and concentrated sulfuric acid. Nitrogen content in spent coffee grounds was determined by Kjeldahl method, potassium by using flame photometer. UV/Vis spectrophotometer was used to measure phosphorus concentration. Concentrations of microelements and heavy metals were determined by using atomic absorption spectroscopy (AAS). Chemical composition of spent coffee grounds is shown in the table.

Table MN*, ME* and other elements concentrations in spent coffee grounds processed with hot water and concentrated sulfuric acid.

Element	Processed with hot water, %				Processed with concentrated sulfuric acid, %			
	Coffee brand							
	Jacobs	Paulig	Lavazza	Caif	Jacobs	Paulig	Lavazza	Caif
N	1.55	2.55	1.99	0.98	2.26	2.52	2.11	2.09
K_2O	0.59	0.67	0.59	0.51	2.87	2.17	2.07	2.17
P_2O_5	0.46	0.68	0.54	0.45	2.53	2.40	1.50	1.76
Fe	–	–	–	–	0.010	0.010	0.0095	0.0177
Mn	–	–	0.00005	–	0.0016	0.0014	0.0016	0.0017
Cu	–	–	–	–	0.00063	0.00068	–	–
Cr	–	–	–	–	0.00073	0.00080	0.00072	0.0004
Ni	–	–	–	–	–	–	–	–
Zn	–	–	–	–	0.0030	0.0073	0.0024	0.0038
Pb	0.00054	0.00038	–	0.00063	0.00078	0.00068	0.00063	0.00064

*MN – Macronutrients; ME – Microelements

Results show that concentration of elements in spent coffee grounds depends on how they were processed. Grounds processed with hot water contain lower concentration of macronutrients than with concentrated sulfuric acid. Except "Paulig" coffee brand, in which concentration of nitrogen processed both ways is almost the same (2.52 – 2.55 %). K_2O and P_2O_5 concentrations in grounds processed with hot water are almost four times lower than processed with sulfuric acid. Concentrations of microelements (Fe, Mn, Cu, Zn) in spent coffee grounds processed with hot water are very low or below analyzer's sensitivity threshold. However, there is no significant concentration difference in grounds processed with sulfuric acid. It is essential to mention that spent coffee grounds contain heavy metals such as chromium (0.004 – 0.0008 %) and lead (0.00063 – 0.00078 %).

Carbon content has been determined by using dichromate oxidation method with concentrated sulfuric acid and results vary between 3.31 – 3.44 %. Moreover, thermogravimetric analysis (TGA) and differential scanning calorimetry (DSC) were used to determine thermal stability and total weight loss of used coffee grounds. The functional groups in spent coffee grounds were identified with Fourier – transform infrared spectroscopy (FTIR). X – Ray Diffraction (XRD) results show that spent coffee grounds are amorphous compound.

[1] https://www.bio-bean.com/news-post/the-significant-value-of-spent-coffee-grounds
[2] https://wood-pellet-line.com/recycling-coffee-grounds-into-biomass-pellets-for-home-heating/
[3] https://newatlas.com/coffee-grounds-biofuel/49473/
[4] https://www.popsci.com/foam-made-from-coffee-can-clean-contaminated water
[5] https://www.gardena.com/lt/sodo-gyvenimas/sodo-zurnalas/paprastumas-is-gamtos-pasigaminkite-trasu/