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THE CHEMICAL COMPOSITION OF YEMENI GREEN COFFEE

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A B S T R A C T

The present study aims to determine the proximate chemical composition of Yemeni green coffee (*Coffea arabica* L.), by analyzing 70 samples which were collected between 2010 and 2011. The moisture content, crude proteins, total lipids, carbohydrates and ash % averages were 6.99 ± 0.48, 10.95 ± 0.44, 6.13 ± 0.36, 22.12 ± 1.77 and 4.16 ± 0.52 %, respectively. Other chemical constituents such as dextrins, chlorogenic acid, and caffeine % averages were 35.89 ± 2.59, 7.19 ± 0.4 and 1.49 ± 0.29 %, respectively. Finally organic and metallic pigments were not found in any of Yemeni neutral green coffee samples.

Keywords: Yemeni coffee, chemical composition, quality grading.

INTRODUCTION

Coffee is one of the world's most popular beverages. It is also the most important consumed and traded food commodity worldwide and ranks second, after crude oil, among all commodities (Fujioka and Shibamoto, 2008). World coffee production grew by over 100% from 1950 to 1990. In 2005 coffee production reached 6.4 million tons worldwide and is projected to grow by 0.5–1.9%, annually. Global output is expected to reach 7.0 million tons in 2010. World consumption of coffee is projected to increase by 0.4% annually from 6.7 million tons in 1998–2000 to 6.9 million tons in 2010. Brazil remains the largest green coffee producer and exporter, accounting for approximately 35% of the world market (Monteiro and Farah, 2012). Meanwhile Yemeni Mocha coffee is regarded as the most traditional coffee and still one of the world's greatest, uniquely delicious coffee. It takes its name from the Yemen port city called Mocha, (USAID, 2005). Most coffee beverage consumed around the world is produced from the species *Coffea arabica* (Arabica) and *Coffea canephora* (Robusta). The former one is considered to be superior due to its sensory properties and, therefore, gets higher prices in the international market (Gielissen and Graafland, 2009). The term "green coffee bean" refers to un-roasted mature or immature coffee beans. These have been processed by wet or dry method for removing the outer pulp and mucilage, and have an intact wax layer on the outer surface. Coffee brew is known as a stimulant, property mainly attributed to caffeine. However, the number of chemical compounds identified in this beverage is large and some of them have many beneficial attributes.

Till date there are no reports on coffee from Yemen, which is the national crop of the country. In the present study the major and minor components have been investigated and the proximate chemical composition of Yemeni green coffee samples have determined.

MATERIALS AND METHODS

Samples: A total of seventy samples of Yemeni green coffee (*Coffea arabica* L.), were collected by Yemen Standardization Metrology and Quality Control Organization from local markets of some Yemeni Governorates during 2010/2011.

Chemicals: The standards of chlorogenic acid and caffeine were obtained from Sigma. Chemical Company. P.O. 145508, St. Lous, USA.

Methods: All chemical parameters such as moisture content, crude protein, total lipids, carbohydrates, ash, dextrins, chlorogenic acid, caffeine and organic and metallic pigments were determined according to the standard method of AOAC (2005), chlorogenic acid and caffeine were determined by using spectrophotometer

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(Spectronic, USA).

Statistical analysis: All the analyses in this study were carried out in triplicate and the results were reported as mean values ± standard deviation. The obtained data were subjected to statistical analysis and the average was compared using Microsoft Excel statistical software (Microsoft Office Excel 2003, Microsoft Corp., Redmond, WA, USA).

RESULTS AND DISCUSSIONS

Data in Table (1) show the observed proximate chemical composition (major components) of Yemeni green coffee samples investigated. The data show that, by analyzing 70 samples it was found that, the moisture content ranged between 5.52 ± 0.42 as a minimum value to 7.77 ± 0.67 % which was a maximum value, meanwhile the average was 6.99 ± 0.48. And by the same way crude proteins ranged between 7.00 ± 0.68 to 16.16 ± 0.28 % and the average was 10.95 ± 0.44 %. On the other hand total lipids ranged between 2.49 ± 0.43 to 13.13 ± 0.24 % and the average was 6.13 ± 0.36 %, meanwhile the carbohydrates ranged between 7.92 ± 0.57 to 35.64 ± 2.23 % and the average was 22.12 ± 1.77 %, whereas the minerals or ash ranged between 3.40 ± 0.40 to 6.51 ± 0.57 % and the average was 4.16 ± 0.52%.

Table 1. The proximate chemical composition (major components) of Yemeni green coffee samples* results % ± S.D (Standard Deviation).

Samples	Moisture content	Crude Proteins	Total Lipids	Carbohydrates	Ash
1	7.47 ± 0.51	10.58 ± 0.21	13.13 ± 0.24	9.35 ± 0.41	3.71 ± 0.47
2	6.57 ± 0.57	11.22 ± 0.21	10.13 ± 0.16	11.04 ± 0.64	3.62 ± 0.42
3	7.36 ± 0.45	10.56 ± 0.33	9.58 ± 0.26	7.92 ± 0.57	3.92 ± 0.57
4	7.25 ± 0.47	10.48 ± 0.24	9.71 ± 0.18	11.38 ± 0.44	5.47 ± 0.45
5	6.82 ± 0.58	9.70 ± 0.22	9.57 ± 0.20	10.80 ± 0.48	6.51 ± 0.57
6	7.65 ± 0.48	11.53 ± 0.26	9.63 ± 0.28	13.76 ± 0.50	4.89 ± 0.64
7	7.21 ± 0.75	11.68 ± 0.27	9.72 ± 0.23	12.39 ± 0.33	3.92 ± 0.44
8	7.30 ± 0.49	8.82 ± 0.28	12.25 ± 0.21	13.25 ± 0.46	3.68 ± 0.47
9	7.13 ± 0.47	12.73 ± 0.28	10.36 ± 0.19	14.57 ± 0.44	3.65 ± 0.47
10	7.51 ± 0.51	11.59 ± 0.25	10.33 ± 0.24	15.31 ± 0.43	3.91 ± 0.45
11	7.55 ± 0.53	11.90 ± 0.27	11.76 ± 0.27	15.36 ± 0.45	3.89 ± 0.53
12	7.77 ± 0.67	13.81 ± 0.28	8.55 ± 0.21	15.35 ± 0.46	4.27 ± 0.49
13	7.37 ± 0.43	13.44 ± 0.27	7.76 ± 0.22	13.27 ± 0.46	4.00 ± 0.37
14	6.89 ± 0.55	11.37 ± 0.29	7.71 ± 0.25	14.19 ± 0.46	3.74 ± 0.45
15	7.66 ± 0.49	10.68 ± 0.29	11.84 ± 0.28	14.76 ± 0.47	3.95 ± 0.49
16	6.47 ± 0.48	12.57 ± 0.33	12.61 ± 0.19	10.20 ± 0.60	3.67 ± 0.38
17	7.45 ± 0.51	11.25 ± 0.31	11.35 ± 0.24	15.42 ± 0.47	3.81 ± 0.39
18	7.34 ± 0.48	13.80 ± 0.29	11.30 ± 0.24	15.11 ± 0.49	3.97 ± 0.39
19	7.66 ± 0.46	8.50 ± 0.22	8.92 ± 0.17	14.85 ± 0.45	3.99 ± 0.46
20	7.24 ± 0.47	7.54 ± 0.21	10.94 ± 0.16	11.02 ± 0.54	4.19 ± 0.52
21	7.26 ± 0.65	14.23 ± 0.32	8.59 ± 0.21	15.05 ± 0.63	4.60 ± 0.47
22	7.70 ± 0.50	16.16 ± 0.28	8.93 ± 0.18	12.44 ± 0.46	4.35 ± 0.48
23	6.81 ± 0.47	15.16 ± 0.15	9.57 ± 0.24	15.62 ± 0.46	4.33 ± 0.45
24	7.45 ± 0.57	9.64 ± 0.17	9.68 ± 0.26	12.79 ± 0.43	3.96 ± 0.58
25	7.41 ± 0.70	10.69 ± 0.23	10.85 ± 0.17	14.16 ± 0.57	3.78 ± 0.46
26	7.25 ± 0.53	9.84 ± 0.18	9.53 ± 0.21	15.99 ± 0.54	4.61 ± 0.43
27	5.56 ± 0.44	9.24 ± 0.44	4.16 ± 0.29	15.39 ± 0.76	4.41 ± 0.54
28	5.64 ± 0.47	8.81 ± 0.45	6.88 ± 0.34	13.37 ± 0.60	4.22 ± 0.39
29	5.52 ± 0.42	9.84 ± 0.46	3.27 ± 0.22	15.43 ± 0.79	4.62 ± 0.42
30	5.79 ± 0.46	10.37 ± 0.50	3.68 ± 0.27	14.82 ± 0.79	4.47 ± 0.34
31	5.55 ± 0.59	10.72 ± 0.47	4.11 ± 0.28	14.85 ± 0.84	4.21 ± 0.48

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32	5.57 ± 0.55	10.86 ± 0.56	3.21 ± 0.22	15.13 ± 0.77	4.32 ± 0.44
33	7.08 ± 0.66	12.65 ± 0.52	3.48 ± 0.23	13.41 ± 0.82	3.40 ± 0.40
34	7.28 ± 0.49	13.90 ± 0.45	3.39 ± 0.26	12.51 ± 0.99	3.79 ± 0.49
35	7.29 ± 0.60	15.64 ± 0.40	4.31 ± 0.23	15.17 ± 0.94	3.65 ± 0.47
36	7.47 ± 0.51	10.50 ± 0.49	3.14 ± 0.23	31.65 ± 3.69	3.71 ± 0.47
37	6.57 ± 0.57	10.33 ± 0.91	4.73 ± 0.45	32.10 ± 3.40	3.62 ± 0.42
38	7.36 ± 0.45	9.89 ± 0.85	2.94 ± 0.22	32.96 ± 3.47	3.92 ± 0.57
39	7.25 ± 0.47	10.03 ± 0.66	2.82 ± 0.36	31.55 ± 3.11	5.47 ± 0.45
40	6.82 ± 0.58	9.59 ± 0.26	2.92 ± 0.36	25.91 ± 2.68	6.51 ± 0.57
41	7.65 ± 0.48	11.56 ± 0.29	5.54 ± 0.47	33.01 ± 2.84	4.89 ± 0.64
42	7.21 ± 0.75	11.95 ± 0.49	4.53 ± 0.69	33.33 ± 3.38	3.92 ± 0.44
43	7.30 ± 0.49	9.24 ± 0.70	4.44 ± 0.56	35.46 ± 3.09	3.68 ± 0.47
44	7.13 ± 0.47	12.78 ± 0.30	3.28 ± 0.39	33.22 ± 2.25	3.65 ± 0.47
45	7.51 ± 0.51	11.58 ± 0.24	2.96 ± 0.39	35.38 ± 2.67	3.91 ± 0.45
46	7.55 ± 0.53	11.59 ± 0.50	3.41 ± 0.56	30.60 ± 2.87	3.89 ± 0.53
47	7.77 ± 0.67	13.91 ± 0.31	4.57 ± 0.47	34.47 ± 2.73	4.27 ± 0.49
48	7.37 ± 0.43	10.98 ± 0.40	3.24 ± 0.48	34.07 ± 3.09	4.00 ± 0.37
49	6.89 ± 0.55	11.04 ± 0.56	4.81 ± 0.70	31.74 ± 2.63	3.74 ± 0.45
50	7.66 ± 0.49	9.87 ± 0.91	3.82 ± 0.56	27.72 ± 3.11	3.95 ± 0.49
51	6.47 ± 0.48	12.17 ± 0.62	3.56 ± 0.63	25.56 ± 2.43	3.67 ± 0.38
52	7.45 ± 0.51	14.07 ± 0.36	4.24 ± 0.48	23.75 ± 2.08	3.81 ± 0.39
53	7.34 ± 0.48	7.92 ± 0.73	4.34 ± 0.36	28.45 ± 3.16	3.97 ± 0.39
54	7.66 ± 0.46	10.58 ± 0.50	3.76 ± 0.48	35.64 ± 2.23	3.99 ± 0.46
55	7.24 ± 0.47	7.95 ± 0.49	5.65 ± 0.45	21.38 ± 2.31	4.19 ± 0.52
56	7.26 ± 0.65	7.00 ± 0.68	2.49 ± 0.43	33.65 ± 2.59	4.60 ± 0.47
57	7.70 ± 0.50	9.91 ± 0.69	4.36 ± 0.57	22.89 ± 2.73	4.35 ± 0.48
58	6.81 ± 0.47	10.83 ± 0.50	3.73 ± 0.48	32.41 ± 2.30	4.33 ± 0.45
59	7.45 ± 0.57	9.37 ± 0.51	4.22 ± 0.65	32.28 ± 2.26	3.96 ± 0.58
60	7.41 ± 0.70	10.34 ± 0.49	3.57 ± 0.49	31.90 ± 2.35	3.78 ± 0.46
61	7.25 ± 0.53	11.90 ± 0.47	2.68 ± 0.37	23.21 ± 2.39	4.61 ± 0.43
62	5.56 ± 0.44	8.01 ± 0.59	3.24 ± 0.64	30.72 ± 2.34	4.41 ± 0.54
63	5.64 ± 0.47	10.60 ± 0.89	4.37 ± 0.57	29.30 ± 2.82	4.22 ± 0.39
64	5.52 ± 0.42	7.84 ± 0.58	2.95 ± 0.52	33.63 ± 3.51	4.62 ± 0.42
65	5.79 ± 0.46	11.50 ± 0.58	3.23 ± 0.69	32.37 ± 2.54	4.47 ± 0.34
66	5.55 ± 0.59	11.78 ± 0.52	3.69 ± 0.54	32.50 ± 2.21	4.21 ± 0.48
67	5.57 ± 0.55	9.65 ± 0.64	3.47 ± 0.56	29.45 ± 2.92	4.32 ± 0.44
68	7.08 ± 0.66	7.80 ± 0.55	3.30 ± 0.41	28.91 ± 3.18	3.40 ± 0.40
69	7.28 ± 0.49	7.60 ± 0.87	3.71 ± 0.46	34.01 ± 2.23	3.79 ± 0.49
70	7.29 ± 0.60	13.42 ± 0.62	3.88 ± 0.53	27.47 ± 3.23	3.65 ± 0.47

* Samples are 70 and the results were in triplicates for each sample.

Because there are a very few studies on Yemeni Coffee, it can be assumed that, the data give us a good and clear image on the major components in Yemeni green coffee samples which represented to the quality grading of Yemen coffee among the other types of coffee in the world. Other researchers in different countries have reported data on the chemical composition of green or roasted coffee especially *Coffea arabica*. In the study by Vasconcelos *et al.* (2007) moisture levels for green coffee are within the range reported in many literatures for good quality coffee (8.5– 13 g/100 g) that is mean Yemeni Green Coffee in this study was more better and less moisture content. On the other hand protein levels for green coffee were also in the range reported in the literature for healthy coffee beans (11– 16.5 g/100 g). Meanwhile, lipid contents of green coffee were closer to the lower limit of the range reported in the literature regarding good quality coffee: 9–16 g/100 g, and the mineral content (ash) in green coffee varied from 4.8% to 6.0%, whereas these results are in harmony with results of present study (Vasconcelos *et al.,* 2007). All these result were in the international trend with the literature review of other researchers who reported that, proteins account for 8% (w/w) to 12% (w/w) of dried green coffee beans. On the other hand, carbohydrates make up about 50% of the dry weight of green coffee beans. The carbohydrate fraction of green coffee is dominated by polysaccharides, such as arabinogalactan, galactomannan and cellulose, contributing to the tasteless flavor of green coffee.Green Arabica coffee beans consist of about 48–60% of polysaccharides. These polysaccharides play an important role in the formation of flavour compounds during roasting and also play a role in the foam stability of espresso coffee. Three types of polysaccharides are predominating in the green coffee bean: cellulose, arabinogalactan type II and galactomannans. As, roasting is an essential step in coffee production for the formation of flavour compounds. During roasting monosaccharides are released which form precursors for flavour compounds during further processing.

Other scientists were investigated the chemical composition of green Arabica coffee beans and they found that, consisted for 55% w/w of carbohydrates. Besides carbohydrates the green Arabica beans contained 11.3% w/w fat and 6% w/w protein. These results are in agreement with the results of this study in Yemeni Green Coffee and the values found in the literature for green Arabica beans, (Oosterveld *et al.,* 2003).

On the other hand the lipids found in green coffee include: linoleic acid, palmitic acid, oleic acid, stearic acid, arachidic acid, diterpenes, triglycerides, unsaturated long-chain fatty acids, esters and amides. The total content of lipids in dried green coffee is between 11.7 g and 14 g / 100 g. Lipids are present on the surface and in the interior matrix of green coffee beans. The two most important coffee species, *Coffea arabica* and *Coffea canephora* var. robusta, contains around 7 to 17% fat. The lipid content of green Arabica coffee beans averages to 15 %, whilst Robusta coffees contain much less, namely around 10%. The lipid fraction of coffee is composed mainly of triacylglycerols, sterols and tocopherols, the typical components found in all common edible vegetable oils. Additionally, the so-called coffee oil contains diterpenes of the kaurene family in proportions of up to 20 % of the total lipids, (Speer and Speer, 2006).

Data in Table (2) show the results of some chemical parameters (minor components) of Yemeni green coffee in 70 samples under this investigation. The data show that the percentage of dextrins ranged between 12.34 ± 0.48 which was the minimum value to 57.87 ± 3.32 % as the maximum value, meanwhile the average was 35.89 ± 2.59 %. By the same way the percentage of chlorogenic acid ranged between 4.24 ± 0.33 to 11.62 ± 0.32 % and the average was 7.19 ± 0.4%, on the other hand caffeine ranged between 0.69 ± 0.16 to 3.19 ± 0.29 % and the average was 1.49 ± 0.29%. Finally the organic and metallic pigments were not found in any of Yemeni neutral green coffee samples. These are good results which demonstrated the high quality grading of Yemeni coffee because the both major and minor components are in the same important for good flavor of coffee, and the small components has very important healthy effects or benefits as the literature has been reported. Such as, Caffeine (*1,3,7-trimethyl-xanthine*) is the alkaloid most present in green and roasted coffee beans, the content of caffeine is between 1% and 2.5% w/w of dry green coffee beans. Meanwhile, non-volatine chlorogenic acids: Chlorogenic acids belong to a group of compounds known as polyphenols, which are antioxidants. The content of chlorogenic acid in dried green coffee beans of robusta is 65 mg/g and of Arabica 140 mg/g, depending on the timing of harvesting. At roasting temperature, more than 70 % of chlorogenic acids are destroyed,

leaving a residue of less than 30 mg/g in the roasted coffee bean. In contrast to green coffee, green tea contains an average of 85 mg/g polyphenols. Coffee is the most consumed beverage in the world and a significant source of phenolic compounds, particularly chlorogenic acids (CGA). Chlorogenic acids (CGA) are the main phenolic compounds in Coffee, being esters of trans-cinnamic acids, such as caffeic, ferulic and p-coumaric acids, with (À)-quinic acid (QA).

Table 2. Determination of chemical parameters (minor components) of Yemeni green coffee samples* results % ± S.D (Standard Deviation).

Samples	Dextrins	Chlorogenic acid	Caffeine	Metallic & Organic Pigments
1	14.48 ± 0.55	7.09 ± 0.19	1.33 ± 0.21	Not Detected
2	17.31 ± 0.54	6.94 ± 0.16	2.77 ± 0.29	Not Detected
3	12.34 ± 0.48	7.61 ± 0.23	1.67 ± 0.33	Not Detected
4	17.69 ± 0.62	6.46 ± 0.29	1.93 ± 0.34	Not Detected
5	17.27 ± 0.51	6.96 ± 0.22	2.67 ± 0.41	Not Detected
6	21.89 ± 0.70	6.50 ± 0.28	2.90 ± 0.37	Not Detected
7	19.51 ± 0.83	6.33 ± 0.32	1.73 ± 0.29	Not Detected
8	20.84 ± 0.65	6.00 ± 0.22	1.01 ± 0.24	Not Detected
9	23.40 ± 0.46	6.14 ± 0.22	1.81 ± 0.36	Not Detected
10	24.39 ± 0.38	5.20 ± 0.22	2.06 ± 0.27	Not Detected
11	24.27 ± 0.47	7.05 ± 0.23	2.41 ± 0.30	Not Detected
12	24.45 ± 0.53	7.09 ± 0.24	1.52 ± 0.33	Not Detected
13	20.91 ± 0.53	5.64 ± 0.25	2.04 ± 0.24	Not Detected
14	22.59 ± 0.69	6.51 ± 0.31	2.18 ± 0.29	Not Detected
15	23.46 ± 0.58	6.99 ± 0.20	0.97 ± 0.23	Not Detected
16	16.20 ± 0.57	7.01 ± 0.21	1.03 ± 0.21	Not Detected
17	24.80 ± 0.49	5.65 ± 0.26	1.02 ± 0.26	Not Detected
18	24.26 ± 0.45	5.18 ± 0.33	3.06 ± 0.24	Not Detected
19	23.50 ± 0.69	5.72 ± 0.31	1.11 ± 0.18	Not Detected
20	17.31 ± 0.51	5.52 ± 0.28	2.23 ± 0.23	Not Detected
21	24.07 ± 0.64	6.32 ± 0.28	1.49 ± 0.30	Not Detected
22	19.69 ± 0.49	6.77 ± 0.26	1.12 ± 0.24	Not Detected
23	24.89 ± 0.68	7.20 ± 0.21	1.03 ± 0.23	Not Detected
24	20.42 ± 0.55	5.62 ± 0.22	3.19 ± 0.29	Not Detected
25	22.55 ± 0.69	5.45 ± 0.24	3.04 ± 0.29	Not Detected
26	25.54 ± 0.71	5.54 ± 0.29	2.31 ± 0.27	Not Detected
27	24.40 ± 0.60	6.58 ± 0.45	0.95 ± 0.14	Not Detected
28	20.60 ± 0.57	5.78 ± 0.46	1.23 ± 0.17	Not Detected
29	24.13 ± 0.71	6.92 ± 0.39	0.86 ± 0.11	Not Detected
30	23.31 ± 0.86	4.52 ± 0.38	1.30 ± 0.20	Not Detected
31	23.87 ± 0.78	6.72 ± 0.37	0.93 ± 0.18	Not Detected
32	24.30 ± 0.63	6.34 ± 0.40	0.69 ± 0.16	Not Detected
33	21.15 ± 0.78	8.74 ± 0.38	1.36 ± 0.23	Not Detected
34	19.48 ± 0.67	5.22 ± 0.41	0.94 ± 0.22	Not Detected

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35	24.43 ±0.69	4.24 ± 0.33	0.75 ± 0.17	Not Detected
36	53.69 ± 3.74	7.13 ± 0.19	1.20 ± 0.30	Not Detected
37	53.76 ± 3.08	7.01 ± 0.20	1.45 ± 0.45	Not Detected
38	53.65 ± 4.61	10.37 ± 0.75	1.50 ± 0.43	Not Detected
39	53.90 ± 3.63	9.31 ± 0.34	1.54 ± 0.42	Not Detected
40	44.77 ± 2.75	10.30 ± 0.49	1.49 ± 0.47	Not Detected
41	55.31 ± 3.96	10.57 ± 0.41	1.35 ± 0.38	Not Detected
42	54.88 ± 3.60	11.05 ± 0.21	1.39 ± 0.30	Not Detected
43	44.97 ± 3.33	6.85 ± 0.60	1.31 ± 0.40	Not Detected
44	56.06 ± 3.42	6.33 ± 0.34	1.65 ± 0.42	Not Detected
45	57.87 ± 3.32	10.19 ± 0.32	1.22 ± 0.39	Not Detected
46	53.59 ± 3.43	6.91 ± 0.32	1.64 ± 0.46	Not Detected
47	57.41 ± 3.40	7.04 ± 0.26	1.53 ± 0.33	Not Detected
48	57.51 ± 2.83	9.55 ± 0.40	1.18 ± 0.41	Not Detected
49	53.98 ± 3.16	11.62 ± 0.32	1.23 ± 0.44	Not Detected
50	46.75 ± 2.79	10.00 ± 0.37	1.11 ± 0.13	Not Detected
51	43.99 ± 3.13	7.15 ± 0.28	1.01 ± 0.22	Not Detected
52	40.68 ± 2.50	7.14 ± 0.31	1.09 ± 0.20	Not Detected
53	46.86 ± 3.59	7.05 ± 0.12	1.04 ± 0.25	Not Detected
54	57.03 ± 3.48	6.40 ± 0.42	1.12 ± 0.18	Not Detected
55	34.14 ± 2.74	6.05 ± 0.26	1.74 ± 0.44	Not Detected
56	56.81 ± 3.20	6.38 ± 0.29	1.39 ± 0.36	Not Detected
57	36.70 ± 3.85	6.75 ± 0.27	1.17 ± 0.29	Not Detected
58	54.01 ± 3.73	7.18 ± 0.21	1.16 ± 0.17	Not Detected
59	54.72 ± 3.21	6.17 ± 0.60	1.55 ± 0.39	Not Detected
60	52.67 ± 3.35	9.29 ± 0.37	1.30 ± 0.34	Not Detected
61	33.68 ± 3.23	11.56 ± 0.41	1.40 ± 0.41	Not Detected
62	50.77 ± 3.31	10.89 ± 0.47	1.50 ± 0.45	Not Detected
63	51.07 ± 3.17	7.94 ± 0.31	1.14 ± 0.30	Not Detected
64	56.43 ± 3.01	7.49 ± 0.37	1.13 ± 0.21	Not Detected
65	52.07 ± 2.79	9.56 ± 0.44	1.55 ± 0.37	Not Detected
66	54.31 ± 3.42	6.56 ± 0.45	1.05 ± 0.18	Not Detected
67	48.15 ± 3.72	7.13 ± 0.36	1.23 ± 0.31	Not Detected
68	49.84 ± 3.03	9.33 ± 0.47	1.57 ± 0.38	Not Detected
69	56.74 ± 3.04	7.23 ± 0.50	1.19 ± 0.36	Not Detected
70	46.68 ± 3.46	7.27 ± 0.37	1.03 ± 0.19	Not Detected

* Samples are 70 and the results were triplicates for each sample.

During coffee roasting, some CGA are partially transformed into chlorogenic acid lactones (CGL). Both CGA and CGL are important compounds for flavor and potentially beneficial to human health, (Perrone *et al.,* 2008). On the other hand Monteiro and Farah (2012) have evaluated the chlorogenic acids (CGA) content and profile in economically important Brazilian cultivars of *Coffea Arabica* of four to five consecutive crops. They found that, the average CGA contents in all cultivars and crops ranged from 6.1 ± 0.7 to 6.6 ± 1.1 g / 100g (dry weight). Meanwhile, assessment of caffeine, trigonelline and chlorogenic acid (CGA) (quinic acid esters) levels in green coffee is very important for the coffee industry, since they have a large effect on the final quality of the coffee products. Caffeine has been related to the pharmacological effects of coffee and both CGA and trigonelline have been associated with flavour formation and aroma production during coffee roasting, there are many analytical methods available for the determination of these components in coffee.

However, high performance liquid chromatography (HPLC) has been the usual technique due to its accuracy, precision and rapidity, (De Maria *et al.,* 1995). Twelve commercial brewed coffees (seven regular and five decaffeinated) were analyzed by Fujioka and Shibamoto in (2008) for chlorogenic acids (CGA) and caffeine by HPLC. And they found that, the total CGAs ranged from 5.26 mg/g to 17.1 mg/g in regular coffees and from 2.10 mg/g to 16.1 mg/g in decaffeinated coffees. The caffeine content in regular and decaffeinated coffees ranged from 10.9 mg/g to 16.5 mg/g and from 0.34 mg/g to 0.47 mg/g, respectively. CGAs are well known secondary metabolites in green coffee beans and are known to contribute to coffee's bitterness, (Campa *et al.,* 2005). There have been many reports on the presence of CGA in green coffee beans. For example, the content of CGA in various green coffee beans (21 species) from Cameroon and Congo ranged from 0.8% to 11.9% on a dry matter basis. The CGA content in brewed coffee may be influenced by the kind of coffee beans used because Arabica beans contain less CGA than Robusta beans. The roasting method might also play an important role in the CGA content of the final coffee product, (Campa *et al.,* 2005).

CONCLUSION

It can be concluded that the Yemeni green coffee samples under this investigation showed a good grade on quality in most chemical composition parameters and these results are the beginning step for all interesting researchers to do many scientific studies on Yemeni coffee which is national crops in Yemen.

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