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Evaluating the effect of decaffeination on nutritional and antioxidant status of different coffee brands

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Abstract

Coffee is the most popular beverage all over the world. Bioactive profile of coffee is enriched with important phytochemicals dominated by the caffeine and chlorogenic acid. Present project uploading the chemical profile of different coffee samples and evaluating the effect of decaffeination on their chemical status. Caffeine contents were varied between 0.036 to 1.18%. Result regarding proximate constitutes increased as a function of storage .Moisture content varies between 1.458 to 1.558% and highest found at 45th day of storage. Among the mineral constituent K dominated as 1386.66 and least was detected in Zn as 0.10mg/100g. Total acidity and PH also changed with change of storage interval. Total acidity was highest in T2 as 120.417 and decreased with increased of storage interval. Total polyphenols found to be in the range of 1490 to 1790 mg /100g and it was least in decaffeinated samples. A same trend was observed for chlorogenic acid that was ranges from 1124 to 1542 mgg/100g and it was also showed reduce value after decaffination. chiorcy was detected negative for all the samples. Different Sensory attributes like taste, flavour, aroma, and over all acceptability pronounced the T4 as best treatment and least scored by the T1.

Key words: caffeine, coffee, chlorogenic acd, chirocy

Introduction

Coffee is the most popular beverage all over the globe its consumption is progressively increasing particularly in the western countries and U.S.A. due to its distinct taste and aroma. It ranks second after petroleum in international trade to earn foreign exchange in many agriculture oriented countries (Ramalakshmi et al., 2008). Coffee belongs to family rubiaceae and to the genra coffea among the hundreds of species only two species namely Arabica (coffee arabica) and robusta(coffee canephora) under commercial cultivation. Arrabica coffee is more appreciated due to its fine taste, aroma and strong body. It is green to pale green in colour have an oval shape in contrast in rubusta that is round and brown in color (Lakenbrink et al., 2000). Coffee possesses enriched antioxidant status compared to other beverage and this may be due to the basic compounds such as chlorogenic acids (42.2%), epicatechin (21.6%), isochlorogenic acid I (5.7%) and isochlorogenic acid II (19.3%), these chemicals are considered as food antioxidants and may protect animal cells against somatic mutations associated with cance (Richelle et al., 2001). Chlorogenic acids (CGA) are the major contributor of antioxidant activity to coffee and these are a family of esters formed between trans-cinnamic acids and quinic acid (Ramalakshmi et al., 2000). These contents are widely distributed in plant materials and their content in green coffee is among the highest found in plants, ranging from 4 to 14% (Farah et al., 2006). Chlorogenic acid contents play an important role in the formation of roasted coffee flavor and have a marked influence in determining coffee cup quality (Farah et al., 2006).

. Furthermore, several beneficial health effects have been attributed to CGA and may be largely explained by their strong antioxidant activities (Moreira et al., 2005). A cup of coffee contains 15-325 mg of chlorogenic acids with an

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average of 200 mg/cup. Roasted coffee beans contain less antioxidant capacity than green beans because most of the chlorogenic acid is degraded during roasting (Nebesny et al., 2003). Similarly Robusta coffee beans exhibited two fold higher antioxidant activity than Arabica coffee, but after roasting this difference were no longer significant and these commonly consumed beverages behave alike (Ginz et al., 2000). Acidity is an important feature of coffee. The main acids in green coffee beans are citric, malic, chlorogenic and quinic. During the roasting process the first three acids decrease while quinic acid increases as a result of the degradation of chlorogenic acids. The acidity and sourness of coffee brews (together with aroma and bitterness) have always been recognized as an important attributes of their sensory quality (Camargo et al., 1998). Coffee has antibacterial and antiviral properties and these antibacterial properties may have arisen from caffeic acid, chlorogenic acid and protocatechnic acid, all of which are the basic entities of it (Dogasaki et al., 2002). This beverage also provides an array of minerals and other nutrients. A single cup of coffee can provide 8 percent of the daily intake of chromium as well as being a significant source of magnesium (Santos et al., 2004). Caffeine (3,7-dihydro-1, 3,7-trimethyl-1H-purine-2,6 dione), a purine alkaloid, is a key component in most popular drinks especially coffee and tea. It is the only component of coffee that is extracted and marketed around the world as a low price additive for cola drinks (Verhoef et al., 2002) as well as in pharmaceutical companies. Caffeine content in coffee plant varies between 1 and 4% dry weight. Different Coffee species contains different caffeine contents varies from 0.4% to 2.4%, while Coffea Arabica and Coffee Robusta beans contains 1% and 2% caffeine, respectively. Coffee Arabica seedlings contains caffeine mainly in leaves and cotyledons at concentrations varying from 0.8% to 1.9% dry wt, while it is essentially absent in roots and the older brown parts of shoots (Zheng et al., 2004). Excessive consumption of caffeine through beverages (coffee) is associated to cause certain health malfunctions as adrenal stimulation, irregular muscular activity, mutation, inhibition of DNA repairs and inhibition of adenosine monophosphodiesterase It also causes osteoporosis, i.e. decrease in mineral density (Bichler et al., 2007). Due to these negative withdrawal effects of caffeine, decaffeination is being carried out widely in coffee to overcome its negative effects (Gokulakrishnan et al., 2005). Decaffeination can be done by organic solvents, water extraction and supercritical carbon dioxide. Eighty percent of decaffeinated coffee is processed with solvents. Conventional methods of caffeine removal are water decaffeination and solvent extraction (Katz et al., 1987). Coffee with 97% or more of its naturally occurring caffeine removed is classified as decaffeinated coffee. Decaffeinated coffee usually loses some flavor over normal coffees and tends to be bitterer. More and more people are switching from regular coffee to decaffeinated coffee. The present study address the extraction of antinutritional factor i.e. caffeine to make decaffeinated coffee and exploring it effects on nutritional and antioxidant status on coffee.

Material and Methods

Procurement of Samples

Different samples of caffeinated and decaffeinated coffee were prepared from the beans and grounded coffee using standard method and products were stored for 45 days. Caffeine was removed and compared with different coffee brands to attenuate its effect on storage and antioxidant status of coffee. Coffee beans and commercial caffeinated and decaffeinated coffee samples were purchased from local market. Reagents and standards were purchased from Sigma-Aldrich (Sigma-Aldrich Tokyo, Japan) and Merck (Merck KGaA, Darmstadt, Germany).

Table 1 attached here

Treatments	Explanation
T_0	**Instant coffee**
T_1	**Coffee beans**
T_2	**Decaffeinated coffee**
T_3	**Commercial caffeinated ground coffee**
T_4	**Commercial decaffeinated ground coffee**

Decaffeination of coffee beans

Caffeine was extracted from the coffee beans by the method described by (Belay et al., 2008).In short first coffee is steamed for efficient reaction of solvent and moisture content was settled in range of 18% that was reached 40% after pre wilting then coffee beans were kept in extractor in presence of methylene chloride as a extracted media. Extraction was completed after10 hours. After those coffee beans is steam stripped to get rid of any metyhlene contents at temperature of 230°F for one and a half hours by using water bath. After stripping the decaffeinated coffee beans were vacuum dried at a temperature of 250°F for a period of 3.5 hours at a pressure of 20 inches of mercury. Then the coffee beans were stored after drying. The coffee beans were also extracted with water for comparative purpose according to the same procedure as mentioned above except, it does not have steaming, pre-wetting and steam stripping steps.

Caffeine Determination

Caffeine was determined in all the coffee samples by the method as described by (AACC, 2000). An accurately weighed amount of sieved coffee 50 mg was dissolved in

25 ml of distilled water. The solution was stirred for one hour using magnetic stirrer and heated gently to remove caffeine easily from the solution. In addition the solution was filtered by a vacuum filter to get rid of particle from solution. Then this solution was mixed with methylene chloride by volume ratio (25:25 ml) for the extraction of caffeine from coffee. First, a mixture of the solution was stirred for 10 min. Then, using separatory funnel caffeine was extracted by methylene chloride from the solution. The extraction of caffeine proceeded 4 times with 25 ml methylene chloride at each round. The caffeine extracted by methylene chloride at each round was stored in volumetric flasks. Finally, the absorbance of the solution was measured by Proximate analysis Caffeinated and decaffeinated coffee samples were analyzed for moisture, ash, acidity, pH, soluble solids, crude protein and crude fat. The methods of all the above parameters are presented as follow:

Proximate analysis

Moisture, ash, protein, fiber and fat and according the method of AOAC (1995).

pH determination

The pH of coffee samples was estimated by the method as described by (Ramalakshmi et al., 2000).The pH was recorded by preparing extractives with ground coffee (3 g) in 50 ml hot water. The extract was cooled to room temperature and pH of the extractive was measured using a pH meter.

Total Acidity

Total acidity in the coffee samples was estimated by treating 10 g coffee sample in erlenmeyer flask with 75 ml 80% alcohol, stopper it and stayed for 16 hr with occasionally shaking. Then filtered and transferred 10ml of filtrate to beaker. The filtrate was diluted to 100 ml with water and titrate it with 0.1N alkali using phenolphthalein as an indicator (Naidu et al., 2008).The results are expressed as ml 0.1 alkali required to neutralize acidity of 100 g sample.

Total Soluble Solids Total soluble solids of the coffee sample was determined by refluxing coffee powder (2 g) with hot water (200 ml) for 1 h and made up to 500 ml. An aliquot (50 ml) was evaporated to dryness, followed by heating in a hot air oven at 105 ± 2 ℃ to get concurrent weights and the amount of total soluble solids was calculated (Naidu et al., 2008).

Determination of Minerals

For mineral determination, wet digestion of all the samples was carried out according to the method of (Alpdogan et al., 2002). 0.5 g of sample was taken in a conical flask. The sample was digested with 10 ml HNO3 at a temperature of 60-70 C for 20 minutes and then digested with 5 ml HCLO4 at a temperature of 60-70 C for 20 minutes and subsequently increasing the temperature to 195 C till the volume of the content was reduced to 1-2 ml. The digested sample was transferred to 100 ml volumetric and volume was made up to the mark using distilled water and then the content was filtered. After filtration, the digested samples were stored for different mineral determination according to their respective methods. Zinc, Manganese, Calcium, magnesium and iron were determined by atomic absorption spectrophotometer while sodium, potassium and calcium were measured through flame photometer.

Total Polyphenols

Total Phenolic content of coffee samples was estimated by the method as described by (Martin et al., 1999) with some modification. Stock solutions of Gallic acid (0.05, 0.10, 0.15, 0.20 and 0.25 µg/ml) were prepared in methanol for preparation of standard solutions. Ground coffee 2 g was dissolved in 30 ml methanol in the flask and placed it in the arbitrary shaker for 1 hr at 40 0C in order to get methanol extract. After sample preparation, 1 ml of appropriately diluted samples and a standard solution of Gallic acid were added to a 25 ml volumetric flask containing 9 ml of double distilled water. A blank reagent using double distilled water was prepared. One milliliter of Folin-Ciocalteu phenol reagent was added to the mixture and shaken. After 5 min, 10 ml of a 7% sodium carbonate solution was added with mixing. The solution was then immediately diluted to a volume of 25 ml with double distilled water and mixed thoroughly. After incubation for 90 min at room temperature, the absorbance at 765 nm was measured. The total phenolic contents of the samples were expressed in milligrams per serving of Gallic acid equivalents (GAE).

Chlorogenic acid determination

Chlorogenic acid was determined in all the coffee samples by the method as described by (Mazzafera et al., 1999). Stock solutions of CGA (10, 20, 30, 40 and 50 µg/ml) were prepared in methanol for preparation of standard solutions. Ground coffee 2g was brewed with 100 ml of distilled water using hot plate. The brewed coffee was immediately cooled to room temperature in an ice bath, after which the samples were filtered using vacuum filter and stored at 5 ℃ until required for Chlorogenic acid determination. The brewed coffee samples (100 µl) were diluted 10-fold and 100-fold with purified water and the absorbance of the resulting solutions were measured at 325 nm with UV–Visible Spectrophotometer.

Chicory Test

Chicory was determined in coffee samples by dissolving 10 g coffee in distilled water for 2-3 minutes and stirred it frequently. Then drain aqueous washings through coarse sieve. The washing of coffee was done with 100ml distilled water and both the washings were centrifuged. Then transferred clear liquid from sediment and drain dry sediment on filter paper, mount in chloral hydrate solution (chloral hydrate solution was prepared by dissolving 8 parts by wt. chloral hydrate crystals in 5 parts of water) (Martin et al., 1998).

The presence of chicory in coffee samples was examined microscopically.

Sensory Evaluation

The Coffee samples were evaluated by a panel of judges from the staff & postgraduate students of National Institute

of Food Science & Technology for color, flavor, aroma, taste, appearance and overall acceptability (Appendix III) according to the procedure described by (Isengard et al., 2001).

Statistical Analysis

The data obtained for each parameter was subjected to statistical analysis using analysis of variance and further significant differences among various levels of our main effect and their interactive effects were explored with Duncan's multiple range tests (DMRt) using statistical software package (Costat Statistical Software 2003).

Results and Discussion

The purpose of the present study was to evaluate chemical attributes of caffeinated coffee beans prior to and after extraction and compared with the commercial caffeinated, decaffeinated and instant coffee samples. Caffeinated and decaffeinated coffee samples were analyzed for moisture, ash, acidity, pH, soluble solids, crude protein and crude fat. The results regarding chemical composition are presented as follow:

Caffeine determination

Caffeine is found in various kinds of foods and drinks that we consume in daily life. Caffeine content varies markedly within species (Martin et al., 1998). Data regarding the means of different coffee brands is presented in table 2 explored that Ti showed highest caffeine contents as 1.25% which was statically similar to the t3 as 1.23% and To(instant coffee) as 1.18%while, lowest(0.036%) among all expressed by T2 (caffeinated coffee beans) which was extracted by water showed least caffeine contents than beans that were extracted with the metyhlene chloride conclude water inability for caffeine extraction.

The caffeine contents of caffeinated and decaffeinated coffee were in the range of 1.23 to 1.25% and 0.036 to 0.041%respectivelywhich were supported by the range of 1.09 to 1.65% and 0.034 to 0.047% respectively that was reported by the (Mazzafera et al., 1999b) another study upload the range of 1.01 to 1.198% for caffeine in the different samples of coffee. More over, (Farah et al., 2006) proposed the range of 1.5%caffiene content in the Arabica coffee. in a past project that disclosed the caffeine content of different coffee brands suggested the caffeine content of different coffee varieties in the range of 1.00-1.9%. The caffeine contents of coffee beans in the range of 0.73-1.07 were reported by (Farah et al., 2001). Alpdogan et al., 2002 illustrated the caffeine content in coffee as 1.36%. The caffeine contents of different coffee samples in the range of 1.26-1.36% were reported by (Sanchez-Gonzalez et al., 2005). Martin et al. 1999 investigated the caffeine content in different coffee samples in the range of 0.9-3.2%.

Table: 2 Means for different brands of coffee and chicory

Treatments	Caffeine (mg/ g)
T_0	11.8 0.12a
T_1	12.5 0.41a
T_2	0.41 0.20b
T_3	12.3 0.15a
T_4	0.36 0.10b

Proximate Analysis

Moisture Content

Water content determination is the most frequent analysis performed in food products and it is quite significant in many aspects (Risso et al., 2007). The moisture contents are very important as these contents limit the storage of the material. Higher amount represent that food commodity has lower shelf life Moisture contents depicted in Table 3 exhibited that T3 (caffeinated ground coffee) showed the highest moisture content as 1.558% which was statistical at par to T0 (Instant coffee) as 1.511% and least moisture contents were recorded in T4 (decaffeinated ground coffee) sample as 1.458%. Over all within the storage intervals the highest moisture contents were observed at 45 days interval followed by interval of 30 days and least moisture contents were recorded at zero days. Moisture level increases with the increase of the storage interval with in the treatments. It was due to the humidity and absorbance of moisture from the environment or due to hygroscopic properties. As T2 (decaffeinated coffee beans) showed non significant relationship with T4 (commercial decaffeinated coffee) thus as a result caffeine extraction did not effected the moisture contents in T2 (decaffeinated coffee beans). The moisture content of different coffee samples were in the range of 1.36-1.66% which were supported by the range of 1.35-1.56% mentioned by (Santose et al., 2001). The moisture levels of different coffee samples in the range of 0.8-1(g/100g) were reported by (Vasconcelos et al., 2006). The moisture content of different coffee samples in the range of 1.30-1.60% was reported by Oliveira et al. 2006

Table: 3 Means for moisture of different coffee brands

Treatment	Days				Means
	0	15	30	45	
T_0	1.420	1.497	1.530	1.597	1.511ab
T_1	1.430	1.473	1.503	1.627	1.508ab
T_2	1.393	1.433	1.467	1.543	1.459b
T_3	1.480	1.517	1.570	1.667	1.558a
T_4	1.36	1.437	1.470	1.567	1.458b
Means	1.417b	1.471b	1.508b	1.600a	

Ash contents

Data regarding treatments means is displayed in Table 4 revealed that T3 (caffeinated ground coffee) showed the highest ash contents as 4.354% which was statistically similar to T1 (caffeinated coffee beans) as 4.152% and least ash contents were recorded in T2 (decaffeinated coffee beans) sample as 3.708%. Over all within the storage intervals the highest ash contents were observed at zero days followed by interval of 15 days and least ash contents were recorded at 45 days. As T2 (decaffeinated coffee beans) demonstrated non significant relationship with T4 (commercial decaffeinated coffee) consequently caffeine extraction did not effected the ash contents in T2 (decaffeinated coffee beans). The ash contents of different coffee samples are in the range of 3.64-4.44% which is in accordance to the range of 3.90-4.42% reported by (27, 31) showed the average ash content in different coffee samples in the range of 4.00-4.9 (g/100g)(32). The ash contents of different coffee samples in the range of 4.40-5.90 (g/100g) were also reported by (Santose et al., 2001).

Table: 4 Means for ash of different coffee brands

Treatment	Days				Means
	0	15	30	45	
T_0	4.10	4.09	4.05	4.03	4.07 [a]
T_1	4.23	4.19	4.12	4.07	4.15 [b]
T_2	3.75	3.37	3.70	3.64	3.71 [c]
T_3	4.45	4.36	4.32	4.29	4.35 [a]
T_4	3.88	3.86	3.18	3.76	3.83 [c]
Means	4.08[a]	4.05 [a]	4.00 [a]	3.96 [a]	

Crude Protein

Protein means deflected (Table 5) that T1 (caffeinated coffee beans) illustrated the highest protein content as 14.26% followed by T3 (caffeinated ground coffee) as 13.94% and the least was recorded in T0 (instant coffee) sample as 9.26%. Over all within the storage intervals the highest protein contents were observed at 15 days of interval followed by zero days and least was recorded at 45 days of interval. The protein content of different coffee samples were in the range of 9.21-14.33%, the same results were reported by (Santose et al., 2001). According to Franca et al. 2005 the protein content of different coffee samples were in the range of 14.24-14.87%. The protein content of different coffee samples in the range of 14.00-16.1% were also reported by Awika et al. 2003.

Table: 5 Means for protein of different coffee brands protein

Treatment	Days				Means
	0	15	30	45	
T_0	9.31	9.28	9.25	9.21	9.27[d]
T_1	14.34	14.30	14.23	14.18	14.26[a]
T_2	13.15	13.34	13.07	12.97	13.14[c]
T_3	14.08	13.97	13.91	13.84	13.95[b]
T_4	13.45	13.44	13.41	13.35	13.4[c]
Means	12.87[a]	12.87[a]	12.77[a]	12.71[a]	

Crude Fat

Data concerning the fat in Table 6 exhibited that T3 (caffeinated ground coffee) showed the highest fat content as 12.84% followed by T1 (caffeinated coffee beans) as 11.90% while the least fat contents were recorded in T0 (instant coffee) sample as 10.77%. Over all within the storage intervals the fat contents were slightly decreased and highest fat contents were observed at zero days followed by 15 days of interval and least was recorded at 30 days of interval. The fat content of different coffee samples were in the range of 9.3-12.3 (g/100g) as reported by (Santos et al., 2001). The fat content of different coffee samples were in the range of 10.36-10.94 (g/100g) as reported by (Martin et al., 1998). The fat content of different coffee samples were in the range of 11.04-12.98 (g/100g) as reported by Oliveira et al., 2006). The fat content of different coffee samples were in the range of 9.00-10.30 (g/100g) as reported by (Santos et al., 2001).

Table: 6 Means for fat of different coffee brands

Treatment	Days				Means
	0	15	30	45	
T_0	10.817	10.797	10.757	10.717	10.772 e
T_1	12.450	12.437	10.387	12.340	11.903 b
T_2	11.360	11.337	11.283	11.223	11.301 d
T_3	12.893	12.890	12.820	12.767	12.848 a
T_4	11.480	11.450	11.413	11.363	11.427 c
Means	11.800 a	11.782 a	11.332 c	11.682 b	

Total Acidity

Means value of acidity (Table 7) upload that the T2 (decaffeinated coffee beans) showed the highest acidity as 137.87 (ml/100g) which was statistical at par to T4 (decaffeinated ground coffee) as 135.667(ml/100g) and

least were recorded in T1 (caffeinated coffee beans) sample the highest acidity was observed at zero days followed by interval of 15 days and least acidity was recorded at 45 days of interval. As T2 (decaffeinated coffee beans) showed higher acidity than T4 (commercial decaffeinated coffee) thus caffeine extraction slightly effected the acidity of T2 (decaffeinated coffee beans). The total acidity of different coffee samples were in the range of 116.167-141.167(ml/100g) which are supported by the range of 78.9-165 (ml/100g) as reported by (32). Mazzafera, (1999) presented the titratable acidity of different coffee samples in the range of 228-267 (ml/100g). The titratable acidity of different coffee samples in the range of 101-114 (ml/100g) was also reported by (Martin et al., 1998)

Table: 7 Means for acidity of different coffee brands

Treatment	Days				Means
	0	15	30	45	
T_0	126.667	125.833	121.833	119.667	123.500^{bc}
T_1	124.333	121.833	119.333	116.167	120.417^{c}
T_2	141.167	139.833	136.667	133.833	137.875^{a}
T_3	125.833	123.000	119.667	117.833	121.583^{c}
T_4	140.000	136.667	134.333	131.667	135.667^{ab}
Means	131.600^{a}	129.433^{a}	126.367	123.833^{a}	

pH

pH of different coffee brands (Table 8) disclosed that T1 (caffeinated coffee beans) demonstrated the highest pH as 5.95 which was statistically similar to T3 (caffeinated ground coffee) as 5.92 and the least pH value was recorded in T4 (decaffeinated ground coffee) sample as 4.93. Over all within the storage intervals the highest pH value was observed at 45 days interval followed by interval of 30 days and least was recorded at zero days. The pH level of different coffee samples were in the range of 4.89-5.98, the same results were reported by (Santos et al., 2001).Franca et al.,(2005) investigated the pH levels of different coffee samples in the range of 5.3-6.52. The pH levels of different coffee samples in the range of 5.91-5.98 were also reported by (Olivrea et al., 2006) (29). It can be observed that, prior to extraction; the caffeinated coffee beans presented the low acidity and high pH values, whereas after the extraction the decaffeinated coffee beans showed high acidity and low pH value.

Total Soluble Solids (TSS)

Means for TSS of various coffee brands in Table 9 demonstrated that T3 (caffeinated ground coffee) showed the highest TSS contents as 28.27% followed by T0 (instant coffee) as 25.45% which was statistical at par to T4 (decaffeinated ground coffee) as 25.14%, while the least TSS were recorded in T1 (caffeinated coffee beans) sample as 120.417(ml/100g). Over all within the storage intervals as 21.88%. Over all within the storage intervals the total soluble solids were slightly increased and highest TSS were observed at 45 days of interval followed by 30 days of interval and least was recorded at zero day. The total soluble solids of different coffee samples were in the range of 21.58-28.38% which was supported by the range of 25-31.02% as reported by(Sanchez-Gonzalez et al.,2000) and illustrated the total soluble solids of different coffee samples in the range of 20.6-26.11%.

Mineral Contents

Minerals are inorganic compounds and their structure is usually nothing more than a molecule, or molecules, of an element. The functions of minerals do not include participation in the yielding of energy. But they do play vital roles in several physiological functions, including critical involvement in nervous system functioning, in cellular reactions, in water balance in the body, and in structural systems, such as the skeletal system. The determination of mineral nutrients in coffee is of great interest, considering the great consumption of this product for millions of people world-wide (Santos et al., 2004) Mineral contents of different coffee brands is presented in Table 10 revealed that among the minerals maximum content was examined for K in the range of 2200 to 1210 mg/100g highest claimed by 2200 (mg/100g) were given by T0 (instant coffee) followed by T4 (decaffeinated ground coffee) as 1408 (mg/100g) which was statistically similar to T2 (decaffeinated coffee beans), while the least potassium contents were recorded in T1 (caffeinated coffee beans) which was statistical at par to T3 (caffeinated ground coffee). Least mineral content was observed for Zn that varies between0.64 to 0.44 mg/100g. T3 exhibited highest zinc content as 0.74 (mg/100gm) followed by T1 (caffeinated coffee beans) as 0.64 (mg/100gm) and least zinc contents were recorded in T0 (instant coffee) sample as 0.44 (mg/100gm) which was statistically similar to T4 (decaffeinated ground coffee). Regarding data T2 (decaffeinated coffee beans) and T4 (decaffeinated commercial coffee) showed non significant relation with one another and displayed significant relation with other treatments. Means of Na reflected from table (9) showed maximum sodium contents as 115 (mg/100g) were given by T0 (instant coffee) followed by T4 (decaffeinated ground coffee) as 70 (mg/100g) while least sodium contents were recorded in T3 (caffeinated ground coffee) as 39.46 (mg/100g). According to the data T2 (decaffeinated coffee beans) showed less sodium contents than T4 (decaffeinated commercial coffee) thus caffeine extraction effect the sodium contents in T2 sample. The means for calcium of various brands of coffee is presented in Table10 revealed that maximum calcium contents as 102.66 (mg/100g) were given by T0 (instant coffee) followed by T1 (caffeinated coffee beans) as 95.206 (mg/100g) which was statistical at par to T4 (decaffeinated ground coffee), while the least

calcium contents were observed in T3 (caffeinated ground explicated highest magnesium contents as 327.46 (mg/100g) were found in T0 (instant coffee) followed by T2 (decaffeinated coffee beans) as 236 (mg/100g), while the least magnesium contents were recorded in T1 (caffeinated coffee beans). The magnesium contents of different coffee samples were in the range of 197.60-327.46 (mg/100g).The sodium contents of different coffee samples were in the range of 39.46-115 (mg/100g). The present results are identical to the findings reported by the other scientists such as Santos and Oliveira, (12). Means for Fe, Cu and Mn is presented in Table10 revealed that they were varied from 5.056 to 9.026, 0.10 to 1.98 and 2.06 to 3.94 mg/100g respectively.T4 (decaffeinated ground coffee) showed the highest iron content as 9.02 (mg/100gm) followed by T1 (caffeinated coffee beans) as 6.08 (mg/100gm) and least iron contents were recorded in T3 (caffeinated ground coffee) sample as 5.02 (mg/100gm). According to the data T2 (decaffeinated coffee beans) showed less iron contents than T4 (decaffeinated commercial coffee) thus caffeine extraction effect the iron contents in T2 sample. The iron contents of different coffee samples were in the range of 5.02-9.02 (mg/100g) which was supported by the findings of Santos and Oliveira, (2001)(12).The copper contents of different coffee samples were in the range of 0.10-1.98 (mg/100g) which were supported by the range 0.03-2.01 (mg/100g) as given by (Grembecka et al., 1998) that exhibited the concentration of copper in the range of 1.21-2.01 (mg/100g) in caffeinated coffee, 1.59-2.00 (mg/100g) in decaffeinated coffee and 0.03-0.12 (mg/100g) in instant coffee. Grembecka et al., (36) determined the concentration of Na in the rang of 3.65-170 (mg/100g) in caffeinated coffee, 39.2-93.9 (mg/100g) in decaffeinated coffee and 2.78-347 (mg/100g) in instant coffee samples respectively. The concentrations of Na in different coffee verities (Robusta and Arabica) were in the range of 1.06-6.6 (%) as reported by The concentration of Ca in different coffee verities (Robusta and Arabica) was in the range of 0.087-0.135 as reported by (Sanchez-Gonzalez et al., 2005). Santos and Oliveira, (2001) reported the concentration of Ca in different Brazilian soluble coffee samples in the range of 106-167 (mg/100g).

Total phenolic contents (TPC)

Phenolics and polyphenolic compounds constitute the main class of natural antioxidants present in plants and may contribute directly to antioxidative action (Awika et al., 2003) therefore it is necessary to calculate total phenolic content. TPC was determined following a modified Follin–Ciocalteu method and results were expressed as gallic acid equivalents. Total phenolic contents in Table 11 revealed highest in T3 (caffeinated ground coffee) as 1720 (mg/100g) followed by T0 (instant coffee) as 1711 (mg/100g) and the smallest amount was recorded in T2 (decaffeinated coffee beans) sample as 1490 (mg/100g). As T2 (decaffeinated coffee beans) contain less phenol contents than T4 (commercial decaffeinated coffee). Data concerning the means magnesium (Table10) Consequently it was concluded that caffeine extraction slightly affected the CGA contents in T2 (decaffeinated coffee beans). The total phenolic contents of different coffee samples in the range of 1490-1720 (mg/100g) which were in accordance to the range of 1400-3740 (mg/100g) as reported by Sanchez-Gonzalez et al.,. The total phenolic contents of different coffee samples in the range of 3040-4080 (mg/100g) were reported by Ramalakshmi et al., (2008) . Martin et al., (1999) investigated the TPC content in different coffee samples in the range of 5-9.5%.

Chlorogenic Acid

Chlorogenic acid (CGA) is one of the key components in coffee responsible for determining the beverage quality as well as its antioxidant activity and in turn for health benefits. Data concerning various coffee brand means is presented in Table 11 exhibited that T1 (caffeinated coffee beans) showed the highest CGA contents as 1542 (mg/100g) which was statistical at par to T0 (instant coffee) as 1509 (mg/100g) and the smallest amount was recorded in T2 (decaffeinated coffee beans) as 1124 (mg/100g). As T2 (decaffeinated coffee beans) contain less CGA contents than T4 (co commercial decaffeinated coffee) thus it was concluded that caffeine extraction slightly effected the CGA contents in T2 (decaffeinated coffee beans). The chlorogenic acid content of caffeinated and decaffeinated coffee samples were in the range of 1379-1542 (mg/100g) and 1124-1336 (mg/100g) respectively which were supported by the range of 526-1710 (mg/100g) in regular and 210-1610 (mg/100g) in decaffeinated coffee samples as reported by Fujioka and Shibamoto, (25). The chlorogenic acid content of coffee samples were 8530 (mg/100g) reported by Ramalakshmi et al., (2004) The CGA content of different coffee samples in the range of 2180-2480 (mg/100g) were illustrated by Franca et al., (2005)(27).Risso et al., (2005) investigated the CGA contents of different Brazilian coffee samples in the range of 1339.8-3579.5 (mg/100mg). Martin et al.,(1999) illustrated the CGA content in different coffee samples in the range of 2.7-4.9%.

Chicory in Coffee

Chicory is a root and contains inulin, hydrolysis of which gives fructose. Coffee does not contain inulin. Therefore, this method was used to test the presence of chicory in coffee. Chicory is a totally natural product from a perennial plant, grown for centuries, cultivated mainly in northern Europe but also found in India, Africa, Florida and California. Chicory is used as a coffee substitute in most of the countries. Chicory was tested in all the coffee samples by using microscope. According to table 12 all the samples showed negative results regarding the presence of chicory when they were checked microscopically. Thus all the samples showed negative results.

Sensory Evaluation

The sensory evaluation of coffee samples for various attributes such as color, flavor, aroma, taste, appearance and evaluated by a panel of judges and the results are described below

Color

Color has a profound influence on the acceptance of coffee and other food products. The means of various brands of coffee are presented in the table 13 exhibited that the highest scores (7.3) were given to T4 (decaffeinated ground coffee) which was statistically similar to T3 (caffeinated ground coffee) as (7.2), T0 (instant coffee) as (7) and T2 (decaffeinated coffee beans) which showed non significant relationship, while the least score was given by T1 (caffeinated coffee beans). Judges rated the T4 (decaffeinated ground coffee) treatment as best which obtained maximum score (7.3).

Flavor

Flavor is also important for the acceptance of product. It is combined perception of taste; smell and mouth feel. Flavor means in table 13 indicated that the best score for flavor was given by T4 (decaffeinated ground coffee) with mean value of 7.7 which was statistical at par to T3 (caffeinated ground coffee) and T0 (instant coffee) which attain same score as 7.4 and lowest score was obtained by T1 (caffeinated coffee beans) with mean value of 5. T1 showed significant relation with all other treatments, while Judges rated the T4 (decaffeinated ground coffee) treatment as best which obtained maximum score (7.7).

Aroma

Aroma also has a profound influence on the acceptance of coffee and other food products. The means of various brands of coffee are presented in table 13 exhibited that the highest scores (7.4) were given to T4 (caffeinated ground coffee) which was statistical at par to T2 (decaffeinated coffee beans) as (6.9) and T0 (instant coffee) as (6.8) which showed non significant relationship, while the least score was given by T1 (caffeinated coffee beans) as (6) Judges rated the T4 (decaffeinated ground coffee) treatment as best which obtained maximum score (7.4).

Taste

Taste of the product is the vital factor to be considered under organoleptic testing. Table 13 indicated that T4 (decaffeinated ground coffee) exhibited best score for taste with mean value of 7.6 which was statistical at par to T0 (instant coffee) with mean value (7), while the lowest score was obtained by T2 (decaffeinated coffee beans) with mean value of 4.2. All the treatments illustrated non-significant ranges except T1 (caffeinated coffee beans). The judges rated the T4 (decaffeinated ground coffee) treatment as best which obtained maximum score (7.6).

Appearance

The means for various brands of coffee are given in table 13 indicated that T4 (decaffeinated ground coffee) displayed best appearance with mean value of 7.8 which was statistically similar to T2 (decaffeinated coffee beans) with mean value of (7.2), T3 (caffeinated ground coffee) and T0 overall acceptability was carried out. The product was

(instant coffee), while the lowest score was obtained by T1 (caffeinated coffee beans) with mean value of 5. Judges rated the T4 (decaffeinated ground coffee) treatment as best which obtained maximum score (7.8).

Overall acceptability

Data regarding means of various brands of coffee is presented in Table 13revealed that T4 (caffeinated ground coffee) showed the highest score as 7.6 which was statistical at par to T3 (caffeinated ground coffee) as (7.4), T0 (instant coffee) as (7.2) and T2 (decaffeinated coffee beans) as (7) while the least score exhibited by T1 (caffeinated coffee beans) as (5.4). Regarding overall acceptability judges rated the T4 (decaffeinated ground coffee) treatment as best which obtained maximum score (7.6).

Conclusions

Phytochemicals are engrossed in our daily life and should be explored within our daily used commodities with special reference to cost and safety. Coffee is frequently used that make it threat to reduce its health claims due to over consumption of caffeine. Effect of removal of caffeine was highlighted positively to its polyphenols and chlorogenic acid contents and proved null and void on its chemical and sensorial parameters. Scantly decaffeination under optimized limit will enhance the coffee nutraceutical worth with little compromise on its taste and appearance.

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