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Nutritional Value of Coffee Made from a Mixture of Coffee Leaf and Spices Used in Ethiopia

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Abstract

In the south western part of the Southern Nations, Nationalities and Peoples Region (SNNPR) in Ethiopia, coffee is prepared not only from coffee bean but also from a mixture of coffee leaf and spices; commonly practiced in Kaffa, Sheka and Bench-Maji zones. The purpose of this study was to determine the proximate and mineral compositions of the coffee and evaluate its nutritional and energy values. The American Public Health Association (APHA) methods were employed for the determination of pH, crude fat and minerals. The phenol sulphuric acid and the Kjeldahl procedures were used for the determination of total carbohydrate and protein, respectively. The amount of energy that could be obtained from the drink was estimated by taking the sum of the proportions of fat, carbohydrate and protein. The percent values were: carbohydrate 0.92 ± 0.21-2.04 ± 0.16, protein 0.19 ± 0.01-0.44 ± 0.02 and fat 2.43 ± 0.49-4.17 ± 0.30. Energy content was 96.05 ± 13.72-434.53 ± 18.33 kcal. Considerable amounts of K (619.29–1910.67), Na (2654.19–3671.61), Fe (4.70–8.57), Mg (33.98-97.45), Ca (24.99–59.58), Mn (0.91–1.58), Cu (0.09–0.24), Zn (0.42–0.78), N (286.48–710.00) and P (24.47–59.10) mg/L were obtained. The Na:K and Ca:P ratios are found to be 1.92–4.27 and 0.62–1.02, respectively. There exist significant differences in almost all the nutrients among the roasted and other types of coffee made from a mixture of coffee leaf and spices ($P<0.05$). Generally, the drink contains significant nutrients vital for energy and health. It could be used as a supplement to satisfy human nutrition needs (food additive) so that it would partially curb nutrition insecurity problems in and out of the region and the country, especially for coffee growing countries.

Keywords: Coffee leaf; Energy; Health; Minerals; Spices

Introduction

Ethiopia is considered to be the birthplace of the coffee plant and of coffee culture. Today, over 15 million people in Ethiopia are involved in the cultivation and picking of coffee, and it remains a central part of Ethiopian culture [1].

In addition to the cultural and social value, coffee is often consumed for its stimulatory effects as caffeine is the most prominent in its composition [2]. It is reported that 70% of caffeine comes from coffee while soft drinks and tea contribute 16 and 12%, respectively [2].

Moreover, coffee contains essential substances for energy and health. For example, a nutritional analysis study on coffee bean showed the carbohydrate (cellulose and hemicelluloses which are 8.6 and 36.7 g/100 g sample respectively); proteins 13.6 g/100 g and minerals: potassium, phosphorus, magnesium, calcium, aluminum, iron, manganese, copper, zinc with contents of 3549, 1475.1, 1293.3, 777.4, 279.3, 118.7, 40.1, 32.3, 15.1 mg/kg of sample, respectively [3].

On the other hand, spices are used for different purposes such as food additives, preservatives and digestive stimulant action [4,5]. They are composed of an impressive list of phyto-nutrients, essential oils, antioxidants, minerals and vitamins; anti-inflammatory, antiviral and anti-cancer properties which increase blood circulation and reduce the risk of heart problems [6]. According to these literatures, addition of some amount of spices could be important for its nutritional and medicinal values.

A socio-cultural practice survey in the south western part of SNNPR in Ethiopia reported that coffee is prepared not only from coffee bean but also from a mixture of coffee leaf and spices. It is also indicated that about 50% of the proportion (on weight basis) is coffee leaf and the other 50%, excluding water, is the sum of all the spices: *Ocimum basilicum, Mentha piperita, Ruta chalepensis, Coriandrum sativum, Lippia javanica, Allium sativum, Anethum foeniculum, Zingiber officinale, Capsicum frutescens, Aframomum corrorima, Allium cepa* and salt (sodium chloride) added as ingredients [7].

It is also reported that in the specified part of the country coffee made from mixture of coffee leaf and spices (here after referred as CCLS) can be prepared in three different processes, and the primary purpose of drinking CCLS in the culture is to obtain considerable energy along with its socio-cultural, medicinal, economical values and stimulatory effect [7]. However, the nutritional and energy value of CCLS is not scientifically tested and reported.

This study was, therefore, intended to investigate the proximate and mineral compositions of CCLS prepared through the three different processes commonly used in Kaffa, Sheka and Bench-Maji zones in Ethiopia, and evaluate its nutritional and food security values in the region and the country.

Materials and Methods

Sample collection and preparation

The ingredients, proportions and processes for sample preparation were employed following the indigenous people practice [7]. The ingredients were collected from the gardens of the local people and the market, if not available in the garden, in Sheka, Kaffa and Bench-Maji zones. One litre samples of each of CCLS types were prepared in the laboratory by the researchers together with three selected indigenous individuals who represent the three types of CCLS, differing only in process of preparation as follows

Type one (Roasted CCLS)

The coffee leaf that is used for one round preparation was cut from the tip of the coffee plant, then roasted on a baking pan and crushed. One litre of water was added into the CCLS pot and boiled. The prepared coffee leaf was mixed with the boiling water (at 100°C) and further boiled for 10 min. Thereafter, all other ingredients *(Ocimum basilicum, Mentha piperita, Ruta chalepensis, Coriandrum sativum, Lippia javanica, Allium sativum, Anethum foeniculum, Zingiber officinale, Capsicum frutescens, Aframomum corrorima, Allium cepa* and sodium chloride) were added and the resulting mixture was boiled for 15 min. Preparation of CCLS is completed at this stage and CCLS is made ready for analysis after filtration.

Type two (Raw CCLS)

This is the same as type one. However, the leaf was not roasted but simply heated over a fire for a short period of time (5 min) and was crushed with its moisture.

Type three (Mejengir CCLS)

The third process is typical to the Mejengir community in Sheka zone of SNNPR in Ethiopia. In this type, the coffee leaf used was the same as type one, but the coffee leaf, Capsicum frutescens, and other needed spices, enumerated in type one, were boiled separately in different pots [7]. The filtrate of coffee leaf was filtered to the spices pot after the boiling stage had been completed. Finally, 30 ml of Capsicum frutescens was added to the mixture.

Determination of proximate composition

Crude fat and pH were determined according to the method described by APHA 2540D, 2540C, 5520B and 4500-H+ B, respectively [8]. The total carbohydrate was determined by following the procedures in Phenol-sulphuric Acid method as reported by Hedge and Hofreiter [9], and the protein content of CCLS samples was determined by the Kjeldahl method following the procedures enumerated in Pearson [10].

Estimation of energy content

The CCLS samples calorific value was estimated (in Kcal) by multiplying the percentage crude protein, crude lipid and carbohydrate by the recommended energy conversion factors [2.44, 8.37 and 3.57], respectively [11].

Determination of minerals

The American Public Health Association (APHA) 3500-K B and APHA 3500-Na B aqua-regia digestion flame photometric (Elico CL-378 flame photometer) method were used for the determination of potassium and sodium, respectively; and APHA 3111 B aqua-regia digestion direct air acetylene flame (PG-990 Atomic Absorption Spectrophotometer (AAS) method was used for the determination of calcium, magnesium, manganese, copper, iron and zinc. For phosphorus determination, APHA 4500-P C, aqua-regia digestion vanado-molybdo-phosphoric acid colorimetric (T-80 UV/Vis Spectrophotometer) method was applied [8].

Data analysis

The proximate and mineral composition values obtained from the three processes of CCLS preparation were compared by performing Analysis of Variance (ANOVA) using SPSS statistical programme version 20. Significant differences among the means were determined using Least Significant Difference (LSD) multiple comparison test and results were considered statistically significant at $p<0.05$. The results were presented as mean ± SD.

Results and Discussion

Proximate composition of CCLS types

The results in Tables 1 and 2 shows that the Roasted type of CCLS contains relatively high composition of nutrients. The pH of CCLS for the three types of samples showed that the drink is quite acidic with a pH range of 4.46-4.57. CCLS was found to contain carbohydrate, protein and fat in the ranges of 0.92-2.04, 0.19-0.44 and 2.43-4.17%, respectively. The results of this study showed that the Roasted type was found to contain the highest amounts of the three macro-nutrients followed by the Mejengir type.

Parameter	Roasted Type	Raw Type	Mejengir Type
pH	4.55 ± 0.11	4.57 ± 0.04	4.46 ± 0.13
Carbohydratea	2.04 ± 0.16	0.92 ± 0.21	1.78 ± 0.23
Crude Proteina	0.44 ± 0.02	0.19 ± 0.01	0.38 ± 0.07
Crude Fata	4.17 ± 0.30	2.43 ± 0.49	3.19 ± 0.46
Energyb	434.53 ± 18.33	96.05 ± 13.72	135.29 ± 15.82
a and b indicates units in %, and Kcal, respectively. Results are presented as mean ± SD			

Table 1: Proximate composition of CCLS types.

The pH value of CCLS was comparable to 4.4-4.6 reported for malt drinks in Nigeria [12], but was significantly lower than non-alcoholic beverages (pH=7.00) spiced with *Zingiber officinale* [13]. The pH was in the range of values recommended for table wine [12]. The difference in pH among the three types of CCLS was statistically not significant ($p>0.05$).

The difference in protein content among the three types, the carbohydrate contents between Roasted and Mejengir type, and the fat contents of Raw and Mejengir types were statistically not significant ($p>0.05$). The value of protein in this study was lower than the 2.2%

reported for a local drink made from Baobab fruit [14]. The fat and carbohydrate values of CCLS were lower than and the protein is almost comparable to most of the Nigerian food supplements [15], which indicates that CCLS could be used as a food supplement in Ethiopia and other coffee growing countries to partly satisfy human nutritional needs. The recommended dietary allowances of carbohydrates are 60-95, 130, 175 and 210 g/day for infants, children, adults and pregnant and lactating women, respectively [16]. Consequently, consumption of a litre of the roasted type of CCLS could provide an average of 20.40 g/day which is 30%, 16.20%, 12% and 10% of the requirements for each of the above groups, respectively. For protein it is recommended to consume 9.1, 13-19, 34-56 and 71 g/day for infants, children, other age groups, and pregnant and lactating women, respectively. Coffee made from mixture of coffee leaf and spices could provide 1.9-4.4 g protein/day if a litre is consumed per day. The recommended value for fat is achieved for infants only, which is 30-31 g/day. However, this amount could be obtained totally from other sources as the infants consume little CCLS in the culture.

Generally, these macro-nutrients provide an average total energy of 96.05, 135.29 and 434.53 Kcal per liter of CCLS consumed for the Raw; Mejengir and roasted types, respectively. These values were lower than the energy value of cinnamon [17]. The energy content of the Roasted CCLS was significantly highest ($p<0.05$), which implies that this type is a better source of energy. This could justify the indigenous people's practice of using CCLS as an energy source.

Mineral content of CCLS

Table 2 also shows that potassium (K) content was 1910.67 ± 31.15, 619.29 ± 52.05 and 619.29 ± 52.05 and that of sodium (Na) was 3671.61 ± 125.15, 2654.19 ± 171.35 and 3590.76 ± 140.78 for the Roasted, Raw and Mejengir types, respectively. The Ca and P contents ranged from 24.99-59.58 and 24.47-59.10 ppm, respectively. The roasted type contained the highest value in both nutrients. The result also showed that CCLS contained a mean of Mg (33.98 - 97.45), Mn (0.91 - 1.58), Fe (4.70 to 8.57), Zn (0.42 to 0.78) and Cu (0.09 to 0.24) ppm.

Parameter	Roasted Type	Raw Type	Mejengir Type
Potassium	1910.67 ± 31.15	619.29 ± 52.05	619.29 ± 52.05
Sodium	3671.61 ± 125.15	2654.19 ± 171.35	3590.76 ± 140.78
Magnesium	97.45 ± 9.35	33.98 ± 5.72	56.59 ± 2.74
Calcium	59.58 ± 4.81	24.99 ± 2.46	32.35 ± 3.51
Iron	8.57 ± 0.11	4.70 ± 0.15	6.47 ± 0.98
Manganese	1.58 ± 0.06	0.91 ± 0.20	1.19 ± 0.16
Copper	0.24 ± 0.09	0.09 ± 0.03	0.18 ± 0.10
Zinc	0.71 ± 0.06	0.42 ± 0.09	0.78 ± 0.17
Nitrogen	710.00 ± 22.40	286.48 ± 28.01	577.84 ± 106.19
Phosphorus	59.10 ± 4.61	24.47 ± 2.97	31.14 ± 4.80
Na:K Ratio	1.92 ± 0.10	4.27 ± 0.13	4.00 ± 0.18
Ca:P Ratio	1.01 ± 0.01	1.02 ± 0.02	0.62 ± 0.10
Results are presented as mean ± SD			

Table 2: Mineral content of CCLS types (in mg/L).

The difference among the K values of CCLS types is statistically significant ($p<0.05$), hence for better K, consumption of the Roasted type could be important. For Na the Roasted and the Mejengir types could be vital as the differences between the two are not significant ($p>0.05$). The values of Na are higher than the values obtained for malt drinks (12.92-38.00 ppm) [9], and higher than K and Na values (130 and 5.6 ppm, respectively) of a local African drink made from Baobab fruit (Adansonia digitata) pulp as reported by Adedayo et al. [14]. The population (>14 years) in the study area consumes a minimum of a litre per day (children consume less than this) of CCLS which contributes part of the Na and K consumption as the recommended acceptable intakes (AI) of K for infants, children and others is 0.4-0.7, 3.0-3.8 and 4.5-4.7, respectively; and that of Na is 0.12-0.37, 1.0-1.2 and 1.2-1.5 g/day, respectively. The K intake can be maximized up to 5.1 g/day for lactating women [16]. Potassium works with Na to maintain the body's normal blood pressure. Increasing dietary K may provide a protective effect against hypertension (high blood pressure) by increasing the amount of Na excreted from the body and reduce risk of death due to cardiovascular disease [18,19]. However, during the preparation of CCLS, salt (sodium chloride) is added which could increase the Na content and makes the Na: K ratio 1.92, 4.27 and 4.00 for the Roasted, Raw and Mejengir types, respectively (Table 2).

Relative to the other types, the ratio of the Roasted type is preferable as Na:K ratio gets minimized which should further decrease below one though it is significantly the lowest ($p<0.05$). A reduction in Na intake of about 0.03 g/day or an increase in K intake of 0.05 g/day is associated with an average 2 to 4 mmHg decrease in blood pressure

[20]. For such a reduction, either the sodium chloride added in CCLS should be minimized or potassium chloride should be used instead so that the Na:K ratio could be minimized. For those people who usually consume K rich food items like vegetables (especially tomatoes), fruits (banana, orange and avocado) and yogurt, CCLS could be important to balance the Na:K ratio [19]. This effect could be the reason why the community uses CCLS as a traditional medicine for hypertension [7]. In general, the Roasted type of CCLS could be preferable as it contains relatively the highest K, Na and lowest Na:K ratio.

Phosphorus (P) and calcium (Ca) are essential minerals for bone development and are needed for optimal bone health throughout life [21]. Statistically, the differences in Ca content of the Roasted type with the other two, and in P of the Raw type with the other two were significant ($p<0.05$). The Ca value of CCLS is significantly higher than the values reported by Adedeyo [12]; Oluwalana and Adedeji [13], but significantly lowers than that of human milk (300 mg/L) and cow milk (1230 mg/L) [22]. For P, the CCLS value is significantly lower than the values of 150 and 960 mg/L reported for human and cow milks, respectively [22]. The recommended dietary allowances of Ca is 200-260, 700-1000 and 1000-1300 mg/day, and that of P is 100-275, 460-500 and 700-1250 mg/day for infants, children and other age groups in both sexes, respectively [17]. This shows that CCLS could be one source of Ca but extra Ca and P sources would be required. The Ca:P ratios in CCLS were 0.62, 1.01 and 1.02 (Table 2) for the Mejengir type, the Roasted type and Raw type, respectively. The latter two almost agree with the optimal dietary calcium-to-phosphorus weight ratio (Ca:P) of 1.3 and cow milk (1.3), but lower than human milk [22,23]. Coffee made from a mixture of coffee leaf and spices could serve as a source of balanced Ca and P during the process of bone hardening or aging, as the Ca:P ratio gradually undergoes increases from 1:1 to 1.67 (above optimum) in this process. In conclusion, for the sake of better Ca, P and Ca:P ratio content consumption of the Roasted type of CCLS could be advisable.

For Mg content, the roasted type contains the highest amount and the difference among the three types of CCLS was significant ($p<0.05$). Daily consumption of a litre of Roasted type of CCLS could satisfy about 100% and 23-40.8% of the daily requirements of children and other age groups, respectively as the recommended dietary allowances of magnesium are 30-75, 80-130 and 240-420 mg/day for infants, children and other age groups of both sexes, respectively [17]. Therefore, consumption of CCLS (especially the Roasted type) could reduce the risk of cardiovascular diseases and atherogenesis such as increasing oxidative stress, cytokine synthesis, nitrogen oxides and mediators of inflammation, and adhesion molecules on microvascular endothelial cells which otherwise would occur due to Mg deficiency in the body [24,25].

Manganese (Mn) is an essential trace element, necessary for development and growth of organisms. The adequate content of this element in the body determines proper metabolism of amino acids, cholesterol and carbohydrates, and influences the activity of several enzymes involved in metabolic and redox processes [26]. The results of Mn content (Table 2) show that CCLS could be used as a good source to obtain adequate amounts of Mn reported to be 0.003-0.6, 1.2-1.5 and 1.6-2.6 mg/day for infants, children and other age groups, respectively [16]. This means that consuming a litre of CCLS could be enough to satisfy the Mn requirement of the human body (except for pregnant and lactating women) if consumed daily. The Mn value of CCLS is higher than the 0.01 ± 0.02 ppm for malt drinks in Nigeria [13], human milk (3-10 μg/L), cow formula (30-50 μg/L) and soy formula (200-300 μg/L) [27], but lower than the result of 13 ppm obtained for a local African drink made from Baobab fruit (Adansonia digitata) pulp [14]. The highest value of Mn was obtained from the Roasted type, and the statistical difference between this type of CCLS and the other two types was significant. Thus, the Roasted type of CCLS is important for consumption.

The Fe content of CCLS was found to be an average of 4.7-8.57 ppm, where the Roasted type contained the highest value and the difference among the three types was significant ($p<0.05$). The dietary allowances for Fe reported for infants, children and other age groups is 0.27-11, 7-10 and 8-18 mg/day, respectively, and it may reach up to 27 mg/day for pregnant women [16]. Thus, consumption of a litre of CCLS (especially the Roasted one) per day could be enough to satisfy the Fe requirement of children and almost all men. For adult women (14-50 years), an additional source of Fe or more CCLS could be needed as Fe is discharged out during regular bleeding (menstruation cycle) [28]. The Fe value of CCLS is higher than the values 0.11-0.28 ppm, 0.4-0.53 ppm and 3 ppm reported for malt drinks in Nigeria, non-alcoholic beverages spiced with *Zingiber officinale* and a local African drink made from Baobab fruit (*Adansonia digitata*) pulp, respectively [12-14]. Generally, using CCLS, specifically the Roasted type, could be important to supplement the Fe requirements of the body.

The value of Zn is almost comparable with 0.25-0.31 ppm, but higher than 0.05-0.10 [9,10]. The Mejengir type contains the highest amount of Zn though the difference is insignificant ($p>0.05$) with the Roasted type. Like the other nutrients, using CCLS (preferably the Mejengir type) also contributes to Zn requirement of the human body.

The Roasted type contains the highest value of Cu which was significantly different ($p<0.05$) with the Raw type. From the dietary reference data, the recommended dietary allowances for Cu for infants, children and other age groups is 200-300, 340-440 and 700-1000 μg/day, respectively and 1300 μg/day for lactating women [16]. Therefore, about 62 and 25% of the daily requirements of Cu for children and adults could be obtained by consuming a litre of the Roasted type of CCLS daily as Cu plays an important role in metabolism, largely because it allows many critical enzymes to function properly, and can act both as an antioxidant and a pro-oxidant [29].

Conclusion

The results of both the proximate and mineral compositions of CCLS are comparable to other energy and mineral drinks studied by other researchers. Together with carbohydrate, protein, fat and minerals, CCLS contains almost optimum K:Na and Ca:P ratios responsible for maintaining the body's normal blood pressure and processing bone hardening, respectively. In addition, it contains Fe which could be useful to supplement the Fe requirement of the body especially for adult women. In general, CCLS is found to contain significant nutritional values vital for energy and health thus plays a part in alleviating nutritional problems in the area.

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