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Nutritional composition and sensory attributes of functional aqualetes fortified with *Cymbopogon citratus* and *Coffea arabica*

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Abstract

Herbal plants like *Cymbopogon citratus (Lemon grass) and Coffea arabica (Green coffee)* possess various phytochemicals that can modulate numerous diseases and their extracts can be added in fruit aqualetes that may improve the health and fulfills their nutritional requirements.The nutritional constituents such as moisture, crude ash, crude protein, crude fat, crude fibre, carbohydrate, iron, calcium and magnesium were analysed according to standard AOAC methods, preliminary phytoconstituents analysis and lastly, the different aqualetes viz; Pineapple , Pomegranate and Orange were developed by the incorporation of singly and equiproportioned mixture of *Cymbopogon citratus* and *Coffea arabica* and their sensory evaluation was performed by 5 point composite score and 9 point hedonic scale through semi-trained panel. In the nutritional analysis, the content of crude ash (7.83±0.94g/100g), crude protein (20.5±0.01g/100g), calcium (14.1±1.40mg/100g) and magnesium (22.08±1.03 mg/100g) were significantly higher in *Cymbopogon citratus* than *Coffea arabica* at P≤0.05 level. Preliminary phytochemical screening depicted that aqueous extract of *Cymbopogon citratus* contain all the bioactive compounds except terpenoids but saponins as well as terpenoids were absent in *coffea arabica.* Among all fruit aqualetes developed, the pomegranate aqualete enriched with 5% *Cymbopogon citratus* was scored highest value (8.5±0.51) which was followed by 5% equiproportioned mixture (7.1±0.51) when compared to standard aqualete. The sensory data suggest that pomegranate herbal aqualetes were more acceptable and comparable to standard while other herbal aqualetes (pineapple and orange) were not acceptable by panel.It is concluded that the *Cymbopogon citratus* had superior nutritional, phytochemical as well as sensory characteristics than *Coffea arabica*. Thus it can be used as a valuable ingredient for the production of herbal fruit aqualetes with natural bequest of nutraceuticals which may showed its pharmacological and therapeutic potential apart from its nutritional essence.

Key words : *Cymbopogon citratus, Coffea arabica*, Aqualete, Proximate Composition, Sensory evaluation

INTRODUCTION

A variety of plant-based therapeutic or prophylactic products have been available for centuries and applied in the treatments of diseases throughout history. Worldwide, phyto-medicine are culturally accepted and universally practiced. They are naturally occurring plant-derived substances with minimal or no industrial processing that have been used to treat illness and are considered as a repository of numerous bioactive compounds possessing varied therapeutic properties. [1]

Cymbopogon citratus is commonly known as lemon grass or citronella grass belongs to Poaceae family. It is an aromatic perennial tall grass with rhizomes and densely tufted fibrous root. [2] It is a native herb from India and is cultivated in other tropical and subtropical countries, which is used as a folk remedy for the treatment of coughs, elephantiasis, flu, gingivitis, headache, leprosy, malaria, ophthalmic, pneumonia and vascular disorders with some pharmacological properties such as antibacterial and antifungal properties.[3] A recent study by the Food and Nutrition Research Institute of the Department of Science and Technology showed lemon grass can help in the prevention of cancer.[4]In addition, it is also consumed as a tea, added to non-alcoholic beverages and baked food and used as a flavoring and preservative in confections and various cuisines. [5]

Coffee arabica also known as Green coffee or arabica coffee is an unroasted green coffee bean which belongs to the *Rubiaceae* family. It is responsible for approximately 70% of the global coffee market, and *Coffea canephora* (Robusta coffee) accounts for the rest. It is green to pale green with an oval shape in contrast Robusta is in round and brown in color and more appreciated due to its fine taste and aroma. [6] Green coffee has been used as a weight-loss supplement and as an ingredient in food products.[7] Scientific evidences have demonstrated that green coffee beverages have high antioxidant properties that are effective against the high blood pressure in human and exert a greater ergogenic effect.

It has been shown that green coffee and lemongrass can enhance vigilance during bouts of extended exhaustive exercise and effective for time trial performance and high intensity exercise. [8]Hence, in the light of the above research facts, the present investigation was undertaken with the objective to evaluate nutritional composition and sensory attributes of fruit aqualetes fortified with *Cymbopogon citratus* and Coffea arabica.

METHODOLOGY

Sample collection and preparation of powder

The fresh *Cymbopogon citratus* was collected from the local Khari baoli market of Delhi and *Coffea arabica* from local fields of Chamrajnagar under National Horticulture Board, Bangalore. The grass and beans were washed in tap water and shade dried after which they were reduced into fine powder by grinding and packed into air tight container for further analysis.

Nutritional analysis

Determination of nutritional composition was carried out in accordance with Association of Official Analytical Chemists. [9] Moisture content was determined by drying in an oven at 100°C for 2-3 hours to constant weight. Crude ash content was determined by weight difference after sample mineralization at

600°C for 4-5 hours. Crude protein was determined indirectly from the analysis of total nitrogen (crude protein= amount of nitrogen×6.25) using Kjeldhal method by Kel Plus analyzer (Pelican, Model: KES-061). Crude fat was determined through Socs Plus system (Pelican, Model: SCS-6) by using petroleum ether. Crude fiber content was determined by digesting dry sample with 1.25% H2SO4, followed by 1.25% NaOH solution in Fibra Plus Fiber analyzer (Pelican, Model: FES-4). Carbohydrate content was estimated by subtracting the values of protein, moisture, ash, crude fiber and fat content from 100.

Mineral analysis

Mineral estimations indicate the amount of inorganic elements present in the sample. The determination of minerals such as iron (Fe) was determined by Wong's method, calcium (Ca) by titration against standard potassium permanganate solution (KMnO4) and magnesium (Mg) was estimated gravimetrically by using standard procedures. [10]

Preparation of aqueous extract and Preliminary phytochemical Screening

20g of powdered plant material was kept in 200ml conical flask and add 100ml of distilled water. The mouth of the conical flask was covered with the aluminium foil and kept in a reciprocating shaker for 25 minutes for continuous agitation at 150 rpm for thorough mixing. Then extracts were filtered by using muslin cloth followed by whatman filter paper No. 42 (125mm). The contained was filtered by using rotator vacuum evaporator with the water bath temperature of 65°C and finally the residues were collected and used for the analysis. [11]The filtrate of grass and beans powder were tested for the presence of various bioactive compounds namely flavonoids (Shonoda test), saponins (Froth Test**),** tannins (FeCl3Test), glycosides (Molisch's Test), steroids (Libermann Test), terpenoids (Salkowski Test) etc. [12]

Development of Aqualetes and Sensory Evaluation

In the present study, three different flavoured aqualetes (pineapple, orange and pomegranate) were developed with variation in each aqualete. There was standard and their three variations were made by incorporating 5g equi-proportioned mixture of both herbs, 5g *Cymbopogon citrates* and 5g *Coffea arabica* extract respectively assigned as Variant A, Variant B and Variant C which was compared with their Standard. Sensory evaluation of the aqualetes were carried out by using 5-point composite scale for all sensory attributes such as appearance, color, consistency, taste and after taste whereas overall acceptability was done by 9-point hedonic scale through semi-trained panel.

Statistical Analysis

The results obtained were expressed as mean ±SD (n=3) and also statistically analyzed to ascertain its significance by student 't' test .The significance was estimated at p≤0.05 level.

RESULTS

Table 1 shows analysis of nutritional composition for moisture, crude ash, crude protein, crude fat, crude fibre and

Table 1: Nutritional Composition of *Cymbopogon citratus* and *Coffea arabica* Powder on Dry Weight Basis

Parameters (g/100g)	*Cymbopogon citratus*	*Coffea arabica*
Moisture	4.83±0.25	5.16±0.41^{ns}
Crude ash	7.83±0.94	3.99±0.06*
Crude protein	20.5±0.01	12.2±0.05*
Crude fat	1.23±0.25	9.91±0.26*
Crude fibre	3.03±0.21	3.27±0.05 ^{ns}
Carbohydrate	63.2±0.30	65.3±0.37^{ns}

Values are expressed as Mean ±SD of triplicate determinations of *Cymbopogon citratus* and *Coffea arabica* powder on dry weight basis. * Shows significant and ^{ns}- non-significant difference at (P≤0.05) level

Table 2: Mineral Composition of *Cymbopogon citratus* and *Coffea arabica* powder on Dry Weight Basis.

Parameters (mg/100g)	*Cymbopogon citratus*	*Coffea arabica*
Iron	1.06±0.14	14.8±0.04*
Calcium	14.1±1.40	5.13±0.13*
Magnesium	22.0±1.03	0.02±0.08*

Values are expressed as Mean ±SD of triplicate determinations of *Cymbopogon citratus* and *Coffea arabica* powder on dry weight basis. * Shows significant difference at (P≤0.05) level

carbohydrate content. Moisture content (g/100g) of *Cymbopogon citratus* and *Coffea arabica* powder were 4.13±0.25 and 5.26±0.41 respectively. This shows that *Cymbopogon citratus* contains significantly low moisture content at P≤0.05 levels in comparison to *Coffea arabica*. Crude protein content (g/100g) of *Cymbopogon citratus* and *Coffea arabica* powder were 20.5±0.01 and 12.2±0.05 and respectively. This shows that *Cymbopogon citratus* contains significantly higher protein content at P≤0.05 level. Crude fat content was 9.91±0.26 g/100g in *Coffea arabica* which was significantly higher value than *Cymbopogon citratus* (1.23±0.25g/100g) at P≤0.05 level. Crude fibre content (g/100g) in *Cymbopogon citratus* and *Coffea arabica* powder were 3.03±0.2 and 3.27±0.05 respectively and found to be insignificant at P≤0.05 level. A Carbohydrate content (g/100g) in both *Cymbopogon citratus* and *Coffea arabica* powder were 63.2±0.30 and 65.6±0.37 respectively which were found to be insignificant at p≤ 0.05 level .

Table 2 represents the result of mineral element composition of *Cymbopogon citratus* and *Coffea arabica* in mg/100g dry matter. The value obtained for calcium and magnesium were 14.1±1.40 and 22.08±1.03 mg/100g which were significantly higher in *Cymbopogon citratus* as compared to *Coffea arabica* whereas iron content (mg/100g) was higher in *Coffea arabica* (14.8±0.04).

PRELIMINARY PHYTOCHEMICAL ANALYSIS

In preliminary phytochemical screening of *Cymbopogon citratus* and *Coffea arabica* aqueous extracts showed that *Cymbopogon citratus* contain all the phytochemicals except terpenoids whereas both terpenoids and saponins were absent in *Coffea arabica* (Table 3.)

The Aqualetes of three different flavours (pineapple, pomegranate and orange) were prepared by the incorporation of *Coffea arabica* and *Cymbopogon citratus* aqueous extract singly and their equi-proportioned mixture assigned as variant A, variant B and variant C respectively which were compared with their standard aqualete as depicted in figure $1_{AB\&C.}$

The mean score of standard pineapple aqualete obtained varied from 4.12±0.44 to 4.47±0.22 in all sensory attributes. The

Table 3: Preliminary Phytochemical Screening of Aqueous Extract of *Cymbopogon citrates* and *Coffea arabica*.

Phytochemicals	Tests	*Cymbopogon citratus*	*Coffeaarabica*
Alkaloids	Dragendroff's test	+ve	+ve
Terpenoids	Lieberman's test	-ve	-ve
Flavanoids	Shinod's test	+ve	+ve
Phenols	5% ferric chloride	+ve	+ve
Saponins	Foam test	+ve	-ve
Tannin	Ferric chloride test	+ve	+ve

- Absence, + present

Figure A

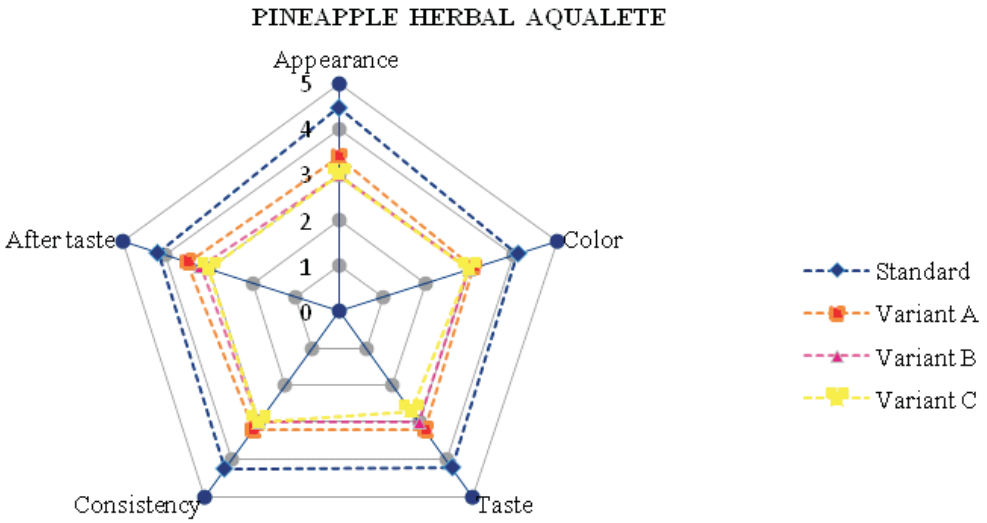

Figure B

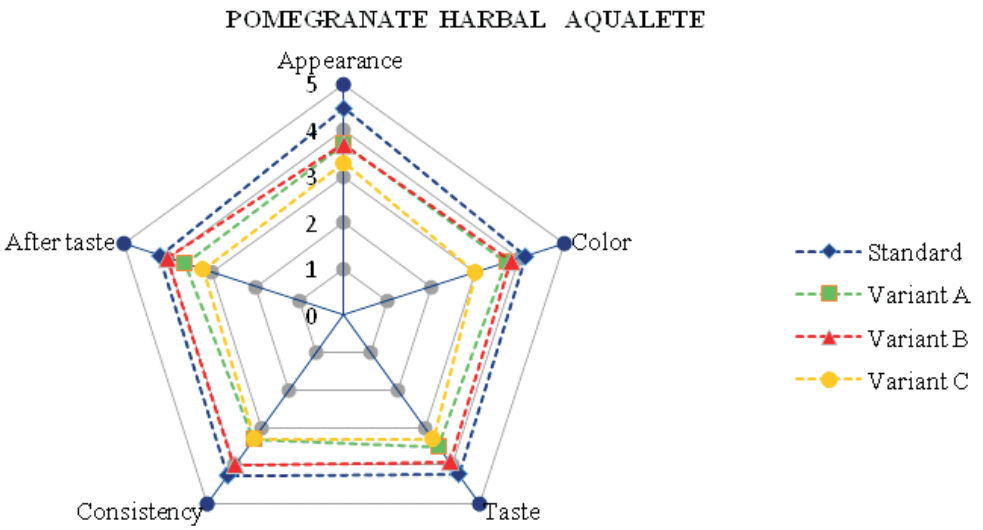

Figure C

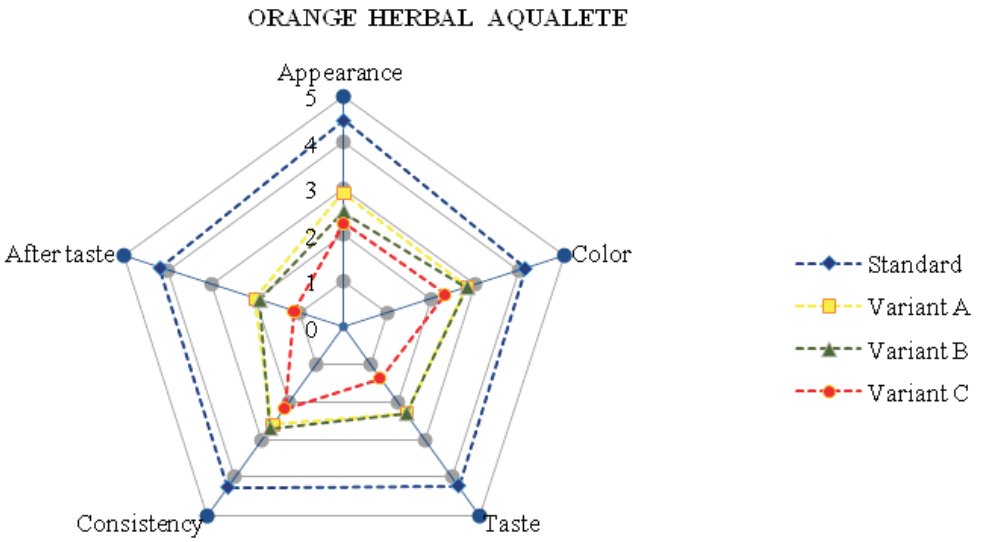

Figure 1 A, B & C : Sensory Evaluation of Pineapple , Pomegranate and Orange Aqualetes of *Cymbopogon citrates* and *Coffea arabica* Powder in the Terms of Sensory Attributes

mean score secured for the all attributes of test pineapple aqualetes were ranging from 2.7±0.6 to 3.5±0.8 as depicted in Figure 1_A However, variant A (pineapple aqualete enriched with 5% equi-proportioned mixture of *Coffea arabica* and *Cymbopogon citratus*) showed the maximum score 3.4±0.5 and 3.5±0.8 in terms of appearance and after taste in comparison to other attributes which was significant at p≤0.05 that means it was slightly liked by semi trained panel. The mean score of standard pomegranate aqualete obtained varied from 4.12±0.44 to 4.47±0.22 in all sensory attributes (Figure1_B).The mean score secured for the all attributes of test pomegranate aqualetes were ranging from 3.0±0.22 to 4.0±0.83 However, variant B showed the maximum score 4±0.82, 4.0±0.75 and 4±0.83 in terms of consistency, taste and after taste in comparison to standard which were non-significant at p≤0.05 that means pomegranate aqualete enriched with *Cymbopogon citratus* (5%) was highly acceptable and comparable to standard aqualete. The mean score of standard orange aqualete obtained varied from 4.12±0.44 to 4.47±0.22 in all sensory attributes. The mean score secured for the all attributes of test orange aqualetes were ranging from 1.12±0.25 to 2.9±0.99 as shown in Figure 1_C. All variants A, B and C showed significant value at p≤0.05 in comparison to standard aqualete that means orange aqualetes enriched with *Cymbopogon citratus* and *coffea arabica* were not comparable to standard aqualete and highly disliked by the semi trained panel.

The mean score of all standard aqualetes varied from 8.5±0.18 to 8.8±0.74 in term of overall acceptability as depicted in Table 4. The mean score secured for all test aqualetes were ranging from 4.2±1.22 to 8.5±0.51. The Variant B (pomegranate aqualete fortified with 5% *Cymbopogon citratus*) showed the maximum

Table 4: Overall Acceptability Evaluation of Aqualetes of *Cymbopogon citratus* and *Coffea arabica* singly and Their Equi-proportioned Mixture

Aqualetes	Standard	Variant A*	Variant B*	Variant C*
Pineapple	8.5±0.18	6.6±0.68*	6.1±0.93*	6.0±0.91*
Pomegranate	8.8±0.53	7.1±0.51*	8.5±0.51ns	6.2±0.97*
Orange	8.8±0.74	4.5±1.17*	4.9±1.07*	4.2±1.22*

Data are reported as Mean ± SD, (n=25), * denotes significant and ns denotes non significant at P≤0.05 Variant A= Aqualete fortified with equiproportioned mixture of *Cymbopogon citratus* and *Coffea arabica* Variant B= Aqualete fortified with 5% *Cymbopogon citratus* and Variant C= Aqualete fortified 5% *Coffea arabica.*

score (8.5±0.51) followed by variant A (aqualete fortified with 5% equiproportioned mixture of Cymbopogon *citratus* and *Coffea arabica*) i.e 7.1±0.51 whereas all other variants of pineapple and orange aqualetes were not comparable and acceptable when compared to their respective standards. Thus, sensory analysis revealed that the variant B and A of pomegranate aqualetes were highly accepted and registered insignificantly different at 0.05≤p level when compared to standard.

DISCUSSION

Fruit aqualetes are becoming popular due to their pleasant flavor and nutritional characteristics. Beverages are consumed by people of all age group to quench the thirst as a social drink and for good health and medicinal values. The medicinal value of the fruit beverages can be enhanced by the incorporation of herbal extracts. Fruits juice could be enriched by addition of herbal extract for preparation of beverages which improves taste, aroma, and nutrition and also contributes to medicinal values. Productions of herbal aqualetes have been increasingly gaining popularity throughout the country due to their health and nutritional benefits. Herbal aqualetes in the form of squashes, appetizers, health drinks are important from the nutritional point of view.

Blum, et al [13] found that *Coffea arabica* had moisture content (6.8%) which was similar data with the present study. *Cymbopogon citratus* had significant higher crude ash content (7.83±0.94g/100g) as compared to *Coffea arabica* (3.99±0.06g/100g) which comparable to data is given by Ujowundu, et al [14]. Dame, et al [15] found that *Cymbopogon citratus* contains 22.59% whereas *Coffea arabica* had 11.2% of protein content according to Mills, et al [16] According to Orrego, et al [17] that *Cymbopogon citratus* contains 2.24% of fat content which is similar to the present study. Similarly, Oestreich-Janzen [18] stated that *Coffea arabica* had fat content (15.2%). According to Vanisha, et al [19] that *Cymbopogon citratus* contains 9.28 % of crude fibre content which is higher value which was similar to the data observed by Braham and Bressani [20] that *Coffea arabica* had 3.4% of crude fibre content. Intake of dietary fibre can lower the serum cholesterol level, risk of coronary heart disease, hypertension, constipation, diabetes, and colon and breast cancer. [21]. A very close to data obtained by Ranade and Thiagarajan [22] that *Cymbopogon citrates* contain 55% of carbohydrate content.

Calcium is essential for bone and teeth formation and development, blood clotting and for normal functioning of heart, nervous system and muscles. Calcium deficiency can lead to ricket, osteomalacia and tooth decay. [23] Similar data given by Njoku and Akumefula [24] that *Cymbopogon citratus* contains 21.4% whereas Gomez Brenes, et al [25] observed that calcium content was 5.4% in *Coffea arabica* which is an agreement with the present study. This shows that *Coffea arabica* contains significantly higher iron content at P≤0.05 levels. Similar data is observed by Komiya, et al [26] that *Coffea arabica* had 15.1% iron content. According to Corti, et al [27] that *Cymbopogon citratus* contains 25.7% of magnesium content which is an agreement with the present study. Similar data is observed by Gomez Brenes, et al [25] that *Coffea arabica* contain 1.1% of magnesium content.

Phytochemicals are biologically active compounds found in small amounts which are not established nutrients but on the other hand contribute significantly to protection against degenerative diseases.[28] Epidemiological studies have shown that phytochemical components possess rich antioxidant properties and have been reported to exert multiple biological effects including antimicrobial, anti-inflammatory activities, free radical scavenger, pain relievers, tranquilizers and metalchelators.[29, 30] They are effective in reducing cardio-cerebrovascular diseases, cancer mortality, hypercholesterolemia and antibiotic properties.[31]

CONCLUSION

Cymbopogon citratus and *Coffea arabica* are medicinal herbs that are used for the treatment of various ailments and debilitating diseases. The outcome of the study demonstrated that 5% *Cymbopogon citratus* pomegranate aqualete was found to be highly acceptable among the other fruit aqualetes in term of overall acceptability while *Coffea arabica* could be incorporated in lesser quantity to develop aqualetes which would be organoleptically acceptable. Thus, it could be concluded that the extracts of the above herbs can be used as a valuable ingredient for the production of herbal fruit aqualetes which can serve as a good nutritional as well as bioactive components which exhibits a wide range of therapeutic potential in the management of innumerable health disorders related to oxidative stress, diabetes and cardio vascular diseases etc.

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