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Impact of lemon grass (*Cymbopogon citratus*) tea on the antioxidant and iron profile of non- Pregnant non- Lactating young womenVanisha Nambiar^{1,*}, Hema Matela¹¹Dept. of Foods and Nutrition, Faculty of Family and Community Sciences, The Maharaja Sayajirao University of Baroda, Vadodara, Gujarat, India

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ABSTRACT

Introduction: Cymbopogon citrates (Lemon Grass) is a traditional food of Asia and is used as folk medicine. Lemongrass has high antioxidant value; however, there is a dearth of human trials showing impact of Lemon Grass on health.

Objective: The present study was conducted to assess the impact of Lemon Grass supplementation on antioxidant and Iron profile of Non-Pregnant and Non Lactating Healthy Adult Women.

Materials and Methods: The 3.5g oven dried lemongrass tea (infused) was supplemented (twice daily) to non-pregnant non- lactating healthy adult women (19-25 years) for a period of 60 days.

Results: it was found that there was significant increase in antioxidant values as assessed by FRAP (17.1±4.3 to 25.5±6.6, $p \leq 0.000$). However, there was a 1.8% reduction in Hb (12.2±1.4 to 11.9±1.4g/dl ($p \leq 0.05$)) levels with an insignificant decrease of Ferritin (6.7%), Erythrocyte (0.6%) Hematocrit (2.6%), MCH (0.5%) and MCHC (0.3%) values. Moreover, there was a decrease in normocytic normochromic subjects from 86.6 to 80.0 percent.

Conclusion: Lemon Grass tea contributes to enhanced antioxidant levels in adult women, however, its effects on the CBC levels need to be corroborated.

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1. Introduction

Human antioxidant defences are effective, but they are not infallible. According to the Free Radical Theory; ageing results by a reduction of antioxidant enzymes and a continued damage of the macromolecules¹ Fruits and vegetables are low energy dense food relatively rich in vitamins, minerals and other bioactive compounds and are good source of fibres.² Several studies conducted have documented antioxidant potential of polyphenols in fruits and vegetables and their correlation in reducing the incidence of degenerative diseases.³ According to WHO, insufficient consumption of fruits and vegetables

are recognised as contributing risk factors to Non-Communicable Diseases (NCDs) burden worldwide.⁴ Thus herbal medicines are increasingly gaining acceptance from the public and medical professionals as they positively influences the health and quality of life.

Lemon grass (LG) is being used as folk medicine since ages in different parts of the world. An earlier study conducted reported that *Cymbopogon citratus* were shown to have free radical scavenging effects.⁵ There are limited clinical trials available on impact of lemon grass on the antioxidant profile of the human population. An earlier study conducted determined antioxidant capacity of lemon grass by different methods i) DPPH (15.96±0.53 μ mole TE/g dw) ii) FRAP (23.40±1.19 μ mole TE/g dw) and iii) ABTS (31.50±0.13 μ mole TE/g dw) to confirm its high

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antioxidant property.⁶

The efficacy of phenolic-rich extracts should be assessed in terms of not only their antioxidant action in vitro but also their potential to interfere with iron absorption.⁷ Polyphenols including EGCG have been shown to chelate metals such as iron.^{8,9} High antioxidant foods such as tea, red wine, and other beverages rich in phenolic compounds, including coffee, are known to inhibit the absorption of non-heme iron.^{10,11} Hence, present study was conducted to assess the impact of LG supplementation on antioxidant and Iron profile of non-pregnant non-lactating young healthy women.

2. Materials and Methods

2.1. Experimental design

Time series.

2.2. Sample size

Following institutional ethical clearance, written consent, and snowball sampling technique, of the 150 students (19-25y), screened from the Department of Foods and Nutrition, Faculty of Family and Community Sciences, following the exclusion criteria and compliance data, the results are discussed for final 30 participants who completed the clinical trial.

2.3. Inclusion criteria

1. Subjects willing to complete the study.
2. Subjects who can provide blood samples.

2.4. Exclusion criteria

1. Illness, or any social events to attend during the study period or other academic commitments

2.4.1. Dose selection

Hypoglycaemic and hypolipidemic effects of the LG was seen when daily oral dose of 125-500 mg/kg body weight of fresh leaf aqueous extract of *Cymbopogon citratus* was supplemented to normal, male Wistar rats for 42 days.¹² Hence taking the reference body weight of Indian adult NPWL women (18-29yrs) as 55kg,¹³ the present study was planned to supplement lemon grass with the dose of 7.00 g/day using following calculation: 125mg/kg x 55kg = 6875mg (6.8g).

2.4.2. Sensory evaluation

A study conducted reported that hot water extract of *Cymbopogon citratus* had high DPPH radical scavenging ability, Fe⁺² chelating ability and OH⁻ scavenging ability than cold water extract;¹⁴ therefore hot water extracts was selected as a mode of supplementation in the present study.

Single daily dose of the Lemon Grass tea was selected by a sensory panel using hedonic test.

Panellists were asked to evaluate coded samples of tea for degree of liking, on a 9-point scale which ranges from like extremely to dislike extremely. More than one sample may fall within the same category.

2.5. Laboratory investigation

2.5.1. Total Antioxidant Capacity (TAC)

The TAC was estimated by Ferric reducing-antioxidant power (FRAP)¹⁵ as it does not measure substantial amounts of serum proteins, including albumin.¹⁶ Chemicals from SIGMA industries were used for reagent preparation and this method is based on the reduction of a ferric Tripyridyl Triazine (TPTZ) complex to its ferrous, coloured form in the presence of antioxidant.

2.5.2. Iron profile

The Sysmex lysing reagent was used for haematological indices and Hb was estimated by Cyanmethenoglobin method.

3. Results

3.1. Sensory evaluation: (Hedonic rating)

It was found that the overall acceptability of the product C (3g of lemon grass) was highest followed by product B (2g) and product A (4g). According to the results obtained by Hedonic rating test, the present study was continued with the 3.5g of lemon grass tea in 150 ml of water (Table 1).

3.2. Details of products

Product A (4g LG), B (2g LG), C (3g LG) with 5g sugar and 150 ml water.

Table 1: Sensory attribute scores of the three recipes (Mean ± SD)

| Sensory attribute | Product A | Product B | Product C | F value |
|-----------------------|-----------|-----------|-----------|----------|
| Colour and appearance | 6.2 ± 1.2 | 8.0 ± 1.2 | 7.0 ± 1.1 | 5.54* |
| Flavour and aroma | 5.6 ± 1.9 | 7.5 ± 1.0 | 7.3 ± 1.4 | 4.52* |
| Overall acceptability | 4.7 ± 1.6 | 7.4 ± 1.0 | 7.7 ± 1.2 | 15.16*** |

F test (****significantly different at $p \leq 0.000$, ***significantly different at $p \leq 0.001$, **significantly different at $p \leq 0.01$, *significantly different at $p \leq 0.05$. NS – non significant)

3.2.1. Diet history

The dietary history was calculated from 24 Hour diet recall method (Table 2). It was found that RDA of macro as well as micro nutrients was not fulfilled except fat.

Table 2: Nutrient intake per day

| Nutrient | Pre % RDA | Post % RDA |
|--------------------|--------------|---------------|
| Energy (Kcal) | 68.8 | 66.9 |
| Protein(g) | 73.0 | 64.8 |
| Fat (g) | 203.8 | 172.4 |
| Carbohydrate(g) | 49.9 | 51.8 |
| Fibre(g) | 37.1 | 33.1 |
| Calcium(mg) | 102.8 | 86.6 |
| Iron(mg) | 54.3 | 64.7 |
| Zinc(mg) | 43.7 | 41.3 |
| Vit C(mg) | 108.4 | 91.0 |
| Thiamine(mg) | 97.9 | 100.0 |
| Riboflavin(mg) | 57.1 | 46.6 |
| Niacin(mg) | 73.0 | 73.0 |
| Vit B 6(mg) | 5.1 | 13.2 |
| Folate (mcg) | 58.0 | 55.1 |
| Vit B 12 (mcg) | 3.0 | 4.6**** |
| Retinol(mcg) | 19.8 | 14.9 |
| Beta Carotene(mcg) | 20.3 | 16.5 |

****significantly different at $p \leq 0.000$, ***significantly different at $p \leq 0.001$, **significantly different at $p \leq 0.01$, *significantly different at $p \leq 0.05$. NS= non- significant.

3.3. Intervention

During the supplementation phase minimum compliance rate ranged from 78% to 100%. Feed-back on liking and disliking of lemon grass tea was taken at two points. Initially only 53.3% of the subjects had liking for the tea, but towards the end of the supplementation it was increased to 73.3%.

3.4. Impact of supplementation on TAC

Impact of daily supplementation of lemon grass tea on the TAC revealed that overall there was a significant increase in the mean antioxidant values from 17.1 to 25.5 $\mu\text{mole TE/ml}$ with mean compliance rate of 90%. The subjects were further alienated in to two groups: Hostelites (n=15) and day scholars (n=15).

It was seen that TAC was significantly improved among Hostelites as compare to day scholars. In day scholars serum antioxidant values increased from 18.2 to 24.3 $\mu\text{mole TE/ml}$ (25% increase) with 86.3% compliance rate whereas in Hostelites serum antioxidant values increased from 16.6-26.2 $\mu\text{mole TE/ml}$ (31.9% increase) with the better compliance of 95%. There was a significant correlation between compliance rate and increased antioxidant values ($p \leq 0.01$). (Table 3)

Frequency distribution of serum antioxidant values depict that there was a marked increase in AO values after supplementation. At baseline 36.6%, 43.3%, 13.3%, 2.6% of the subjects had AO value as <15, 15-19.9, 20-24.9 and >25 $\mu\text{mole TE/ml}$, respectively. Whereas at the endline (after supplementation) the trend had become upturned as

none of them had AO less than 15 $\mu\text{mole TE/ml}$.

Table 3: Impact of lemon grass tea on serum TAC ($\mu\text{mole TE/ml}$)

| Variables | Pre data | Post data | Correlation with Compliance (r value) |
|------------------------------|-----------|---------------|---------------------------------------|
| Total subjects (N=30) | 17.1± 4.3 | 25.5± 6.6**** | 0.540 ** |
| Hostelites (n=15) | 16.6± 4.1 | 26.2 ±7.5 *** | 0.55 * |
| Day scholars (n=15) | 18.2± 4.5 | 24.3± 5.6* | 0.732** |

****significantly different at $p \leq 0.000$, ***significantly different at $p \leq 0.001$, **significantly different at $p \leq 0.01$, *significantly different at $p \leq 0.05$.

3.5. Impact of lemon grass on iron status indicators

3.5.1. Impact on Hb and ferritin levels

After Lemon grass supplementation it was observed that there was 1.8% (12.2 to 11.9 g/dl) decrease in the mean Haemoglobin levels of the subjects. There was a non-significant decrease in the Serum ferritin levels. To better understand the effect lemon grass on iron status other haematological indices were also studied (Table 4).

3.5.2. Other Haematological indices

After supplementation there was non- significant increase in Mean corpuscular volume (MCV). The mean corpuscular hemoglobin (MCH), Haematocrit, Mean Corpuscular Hemoglobin Concentration (MCHC) and erythrocyte values were non-significantly reduced (Table 4).

3.5.3. Impact on red cell Morphology

It was found that Normocytic normochromic individuals decreased from 86.6 to 80 percent and prevalence of abnormal morphology increased from 13.3% to 20.0%. Moreover it was found that microcytic hypochromic individual increased from 6.6 to 13.3%, whereas frequency of individuals having normocytic Hypochromic and Macrocytic red blood cells remains same (Table 5).

4. Discussion

In the present study after 60 days of supplementation of lemon grass there as a significant increase in serum antioxidant value (17.1 to 25.5 $\mu\text{mole TE/ml}$). Lemon grass is proved as a strong antioxidant agent in-vivo hence complements the laboratory findings that it has antioxidant capacity. An earlier study conducted documented that Lemon Grass has better antioxidant capacity than Coriander (leave and stem), Ginger, Tomato and Garlic. And less TAC than Turmeric, Cumin, dried Curry powder.¹⁷

Table 4: Impact of supplementation on iron status indicators

| Variables (N=30) | Pre data | Post data |
|----------------------------|-------------|---------------------------|
| Haemoglobin | 12.2 ± 1.4 | 11.9 ± 1.4* |
| Ferritin (ng/ml) | 21.0 ± 20.4 | 19.6 ± 18.7 ^{NS} |
| Erythrocyte (milli.cu.mm.) | 4.4 ± 0.4 | 4.4 ± 0.4 ^{NS} |
| Hematocrit (PCV) (%) | 37.8 ± 3.2 | 37.3 ± 3.6 ^{NS} |
| MCV (fl) | 84.9 ± 7.3 | 84.9 ± 8.1 ^{NS} |
| MCH(pg) | 27.3 ± 3.4 | 27.1 ± 3.5 ^{NS} |
| MCHC (g/dl) | 32.0 ± 1.5 | 31.9 ± 1.6 ^{NS} |

****significantly different at $p \leq 0.000$, ***significantly different at $p \leq 0.001$, **significantly different at $p \leq 0.01$, *significantly different at $p \leq 0.05$. NS (non-significant).

Table 5: Impact on Red cell morphology of the subjects

| Red cell morphology | Pre data % (n) | Post % (n) |
|-------------------------|----------------|------------|
| Normocytic Normochromic | 86.6 (26) | 80 (24) |
| Normocytic Hypochromic | 3.3 (1) | 3.3 (1) |
| Microcytic Hypochromic | 6.6 (2) | 13.3(4) |
| Macrocytic | 3.3 (1) | 3.3 (1) |

Studies conducted have also reported that lemon grass has high phenol and flavonoids content.¹⁸ Polyphenolic monomers; particularly tannins are considered as antinutrient however more recently these compounds are considered as important dietary antioxidants.¹⁹ Tea from the other sources like *Camellia sinensis* which is known source of antioxidant also inhibits the iron absorption,²⁰ coffee also was shown to inhibit iron absorption in humans in a dose-dependent manner.²¹ It is proposed that the amount and category of polyphenols present in foods will compute the inhibitory effect, *Cymbopogon citratus* leaves had low concentrations of Phytate & oxalate (0.48mg/g) and Tannin was not detected,²² therefore it can be predicted that lemon grass would have less interference on iron absorption than green and black tea.

Average Iron intake in studied population was found to be 13.6±4.4 which is only 65% of the RDA. Absorption of iron from various Indian diets was found to vary from 7-20%²³ and it is said that Ascorbic acid promotes iron absorption, this effect can be achieved with the amounts of ascorbic acid obtained in foods however, average Vitamin C intake of samples studied in present study was 54.6mg/d on comparing with other countries it is very low as Greek diet provides 214mg/d of vitamin C²⁴ and median daily intakes in the Spanish EPIC cohort was 137mg/d²⁵ which is very low therefore decrease in Hb. is not exclusively attributed to phenols present in lemon grass it is a cumulative outcome of inadequate consumption of dietary iron, low intake of absorption enhancer and additional phenol supplemented by lemon grass tea hence further studied are need to be done in this area.

5. Conclusion

Thus, it can be concluded that the LG tea had significant positive correlation on the TAC as assessed by serum FRAP analysis. Tea is the second most popular consumed beverages. As in the present study the taste of LG tea is acceptable, therefore for it can be an effective food based approach for improving antioxidant defence system of the body hence preventing degenerative diseases.

Quantity of lemon grass consumed is an important factor to be kept in mind for having positive health benefits as Lemon Grass is responsible for negative impact on bioavailability of iron therefore adequate iron absorption enhancer should be consumed.

Many other functional foods are easily available, underutilized and add to the overall antioxidant intake in daily diets such as drumstick leaves, radish leaves, pomegranate peels, cauliflower greens, Bael leaves, Amaranthus red and green leaves, coriander leaves and millets such as pearl millet^{16–18,22} need to be promoted. Dietary diversity and healthy diet promotion at the community level is the need of the hour.

6. Conflict of Interest

None.

7. Source of Funding

None.

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