



Research Article

Sensory Evaluation of Iron Fortified Tea

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Abstract

Introduction: Iron deficiency is a major contributor to maternal mortality. As tea is widely consumed in East Africa, it is a candidate for iron fortification. Unfortunately, iron compounds form dark, poor tasting, non-bioavailable complexes with tea tannins. The effectiveness of technology developed at the University of Toronto for prevention of this reaction was tested by evaluating the acceptability of iron fortified tea by trained and consumer sensory panels.

Methods: Ten panelists and 60 untrained participants (both male and female) of different social-economic backgrounds assessed iron fortified tea brewed by 4 local techniques, using the 9-point Hedonic scale at Haydom, Manyara Tanzania.

Results: Majority of the panelists liked iron fortified tea prepared by brewing in a mixture of water, tea leaves and sugar in a tea pot, or by steeping the iron fortified tea brewed with or without milk. More than three-quarters of the participants were fond of the iron fortified tea appearance, however, most noted that the tea was blacker than tea commonly consumed in the area. All participants liked its taste and the aroma.

Conclusion: The iron fortified tea was well accepted by average consumers at Haydom, despite noting the slight darkening of the tea colour.

Implications: The results indicate that it is possible to iron fortify tea, retaining its sensory attributes and bioavailability. This opens the possibility of reducing maternal and infant mortality by iron fortification at a low cost, reaching rural poor in East Africa, and elsewhere.

Background

One third of world's population is anemic and half the cases are due to Iron deficiency [1,2] Anemia is the leading cause of morbidity and mortality among all age groups; affecting mostly children under five and adolescent girls [3]. Iron deficiency affects red blood cell synthesis leading into hypochromic microcytic red blood cell. Causes of iron deficiency anemia includes diets low in bioavailable iron and blood loss due to infection or bleeding. About 75% of adolescents worldwide do not consume the dietary requirements for iron [4].

Iron deficiency may be reduced though fortification of commonly consumed foods [5]. While iron fortification of manufactured foods, such as flours and their derivatives is becoming wide-spread, poor rural populations have not benefited

from this intervention, as they do not consume manufactured foods. Tea could be an ideal micronutrient carrier because it is the most widely consumed beverage globally (after water), and tea consumption in many areas of the world is independent of social status. However, tea fortification of iron has not been successful in the past, as the tannins in tea readily form highly coloured, unpleasant tasting complexes, that reduce the bioavailability of both the beneficial tea polyphenols and the added iron [6-8].

To overcome this problem, the University of Toronto's food engineering group developed technology based on adding competing complexing agents to tea, thus preventing the formation of the undesirable tannin complexes. The patented process consists of attaching a complexing agent and a bland tasting, bioavailable iron compound to tea, which is released during brewing. The complex, binder and iron compound are all GRAS, and can

provide up to 30% of RDI based in 500mL tea brewed from 1-2% by weight tea leaves [9-11].

This formulation of iron fortified tea has not been tested clinically and before such trial it is prudent to ensure that the product will be acceptable to the target consumers. This study assessed consumer opinions on the appearance, colour, taste and odour of iron fortified tea in East African, specifically Tanzanian rural settings.

Methodology

Study site

The study was conducted at Haydom town, in Mbulu Manyara, Tanzania. Haydom town is located in Northern Tanzania about 300 km from south of Arusha town at an altitude of 1700m above sea level. The area is inhabited by poor rural communities with challenges of micronutrient, including iron, deficiencies. The communities use both soft (rain) and hard (surface and underground) water for their domestic use including cooking and drinking.

Ethical clearance to conduct the survey was obtained from the National Institute for Medical Research Ethical Review Committee in Tanzania. Informed written consent was obtained from each participant before participating in the study.

Tea testing protocol

Tea was prepared by two methods, each with and without milk: Water was boiled in a Betty Crocker electric kettle. Iron fortified local, Tanzanian tea leaves were placed in a tea ball infuser and added to hot water (above 94°C) and sugar was added as per consumers taste. In the preparation 1% by weight ratio of leaves to water (usually 2.5 g in 250 mL of water) were used. The mixture was gently stirred, allowed to steep for 5 minutes, and then gently stirred again. After this, the tea leaves were removed from the solution by the tea ball infuser. Alternately, the tea leaves were brewed in boiling water (above 94°C) and served with sugar.

In both cases milk was added for those who wished to have tea with milk. Brewed iron fortified tea was assessed for appearance, colour, taste and odour.

Study subjects

Trained panel: ten people trained in using the 9 point Hedonic scale formed a panel [12].

Untrained panel: a total of 60 participants from different socioeconomic backgrounds, education and occupation profiles were selected. Of these participants, 39 were female and 21 were male, 31/60 (51.7%) were above 30 years of age and the rest between 18-29 years age. Each subject was provided with a cup of iron fortified tea prepared by brewing tea leaves in boiling water (above 94 °C) and served with sugar. Thereafter they filled a self-administered questionnaire.

Focus group: thirty panelists from the untrained group were randomly selected, and took part in one of five parallel focus groups to discuss the iron fortified tea shortly after tasting.

Several themes related to the appearance/colour, taste and smell of the brewed iron fortified tea emerged in these interactive discussions that lasted up to twenty minutes.

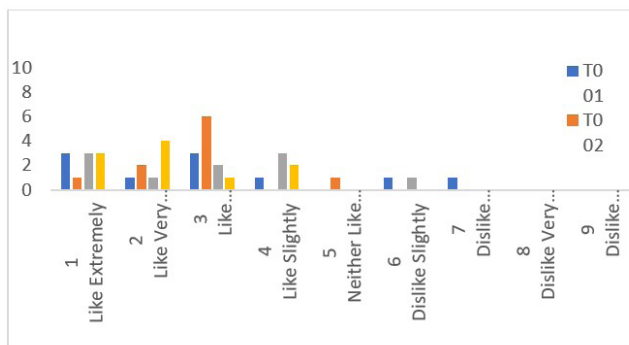
Data management and analysis

Data collected using 9 points Hedonic scale form and a pre-formed questionnaire were entered and analyzed using Excel. Both tables and histograms were generated for data presentation.

The qualitative data from focus group discussions were collected as a voice recording with written moderator notes. The recordings were transcribed and then translated from Swahili (local language) to English, then back-translated by another independent translator competent in both Swahili and English to ensure consistency. Qualitative content analysis methodology was employed. Texts were thoroughly read and meaning units were identified. The meaning units were then condensed into codes which later formed themes presented here.

Results

Ten panelists evaluated four iron fortified teas prepared by the four typical local preparation methods using the 9-point Hedonic scale for overall evaluation of acceptability. The Figure 1. shows the panelist evaluation scores of the four forms of preparation of iron fortified tea.



Blue= T001, Red = T002, Grey = T003 and Orange= T004

T001 Fortified tea leaves placed in the tea ball infuser immersed in a cup of hot water (>94 °C) and sugar added as per consumer's taste

T002 Fortified tea leaves placed in the tea ball infuser immersed in a cup of hot water (>94 °C) , milk and sugar added as per consumer's taste

T003 Fortified tea leaves and sugar boiled with water in a tea pot to above 94 °C

T004 Fortified tea leaves, milk and sugar boiled with water in a tea pot to above 94 °C

Figure 1: Panelist opinions regarding Iron fortified tea of different preparations.

The majority of the panelists liked the iron fortified teas, giving slight preference to tea presented with milk. Out of 10 panelists, 70% liked the iron fortified tea mixed with boiled water and sugar, while 90% liked it when brewed with sugar and boiled together in the water, and 90% liked it when mixed with milk. Fortified tea prepared by placing tea in the tea ball infuser with hot water (>94 °C) added through the diffuser into a cup and sugar added as per consumer's taste was the least liked, but even this was liked to some extent by 80% of the panel.

Sixty untrained panelists were presented with one cup of tea, and were asked to rate the tea on four attributes. A half of these were randomly asked to participate in a focus group discussion, to elaborate on the results.

Appearance and colour

The majority of the tasters noticed no difference in the appearance of fortified tea, when comparing with unfortified tea that they were accustomed to consuming in the past. They only noticed that iron fortified tea was slightly blacker than what they expected from unfortified (commonly used) tea. Initially most of them thought that the dark colour was due to excessive tea leaves. When they prepared the tea themselves using a small amount of iron fortified tea leaves they still found that the tea was blacker than unfortified tea. The responses are presented in Table 1.

| | Number | Percentage |
|-------------------------|--------|------------|
| Like extremely | 23 | 38.3 |
| Like very much | 14 | 23.3 |
| Like moderately | 13 | 21.7 |
| Like slightly | 8 | 13.3 |
| Neither like or dislike | 0 | 0 |
| Dislike slightly | 2 | 3.3 |
| Dislike moderately | 0 | 0 |
| Dislike very much | 0 | 0 |
| Dislike extremely | 0 | 0 |

Table 1: The consumers' perception on appearance/colour of the iron fortified tea.

Some quotes:

FGD5. R2... "I don't know whether you put more tea leaves or not, the colour looks more black than normal tea"

FGD1. R4. "I like it looks like common tea I am used to, except the colour, looking at it intensely, looks like its colour is too black, different from normal tea..."

FGD2. R3. "It looks like other tea we use at home no difference"

Taste

The majority of the participants in the survey liked the taste of the iron fortified tea. None of the participant noticed any unpleasant taste. All participants in the FGD indicated that the taste of the iron fortified tea was not different from unfortified tea (Table 2). They have not tasted any difference, as the quotes below confirms.

| | Number | Percentage |
|-------------------------|--------|------------|
| Like extremely | 26 | 43.3 |
| Like very much | 16 | 26.7 |
| Like moderately | 7 | 11.7 |
| Like slightly | 10 | 16.7 |
| Neither like or dislike | 0 | |
| Dislike slightly | 1 | 1.7 |
| Dislike moderately | 0 | |
| Dislike very much | 0 | |
| Dislike extremely | 0 | |

Table 2: The consumers’ perception on the taste of the iron fortified tea.

Some quotes:

FGD2. R3..... “It taste as normal tea”

FGD3. R4. “It looks like chai bora we used at home, has good aroma”

FGD5. R2. “Regarding taste, is good, I like it, is not different from common tea...”

Aroma/odour

The majority of the participants found the aroma is pleasant, not different from the common unfortified tea they normally use. The data is tabulated in table 3.

| | Number | Percentage |
|-------------------------|--------|------------|
| Like extremely | 24 | 40.0 |
| Like very much | 16 | 26.7 |
| Like moderately | 12 | 20.0 |
| Like slightly | 7 | 11.7 |
| Neither like or dislike | 0 | 0 |
| Dislike slightly | 1 | 1.7 |
| Dislike moderately | 0 | 0 |
| Dislike very much | 0 | 0 |
| Dislike extremely | 0 | 0 |

Table 3: The consumers’ perception on the aroma of the iron fortified tea.

Some quotes:

FGD1. R1 “I have not smelled any unpleasant smell”

FGD1. R2 “On the side of odour, it has no smell which you can say is bad, it has good aroma which I like”

FGD4. R1....”except it has slightly different smell”

FGD4. R2. “Regarding smell, is good I like it”

FGD5. R3 “.....the aroma is ok”

FGD2. R4.” the aroma, which is a bit different...”

Overall evaluation

Table 4 presents the overall opinion of the participants on whether they like or dislike the iron fortified tea.

| | Number | Percentage |
|-------------------------|--------|------------|
| Like extremely | 32 | 53.3 |
| Like very much | 11 | 18.3 |
| Like moderately | 7 | 11.7 |
| Like slightly | 9 | 15.0 |
| Neither like or dislike | 0 | |
| Dislike slightly | 1 | 1.7 |
| Dislike moderately | 0 | |
| Dislike very much | 0 | |
| Dislike extremely | 0 | |

Table 4: Distribution of overall opinions of the tasters.

More than three quarters (83%) of the participants in the survey said they like the iron fortified tea (moderately to extremely). Most of the respondents in the FGD said that they had not noticed any obvious difference between the iron fortified tea and their usual beverage, and therefore they liked the iron fortified tea. The summary of the preferences of the untrained panel members are presented in Figure 2.

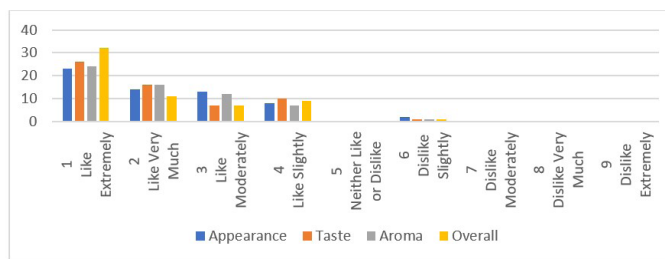


Figure 2: Tea Taste Panel Summary Untrained testers.

Some quotes:

FGD1. R1. “You won’t notice any difference as you drink this type of tea, is like normal tea, so I love it”

FGD1. R2 “First of all the tea is good, and it is sweet as normal tea”

FGD3. R4. “On my side it was difficult to notice the difference when compared with other normal tea..... to me it looks similar to the tea I am using at home”

FGD5. R2 “....may be the color if there is any possibility to make it a bit light can be of help. The deep black color may make people anxious. If one is not comfortable due to color may not be happy to use it.....”

Conclusions

Based on the responses of the testers, who were representative of the local population, but were not trained tea tasters, it is clear that tea fortified with iron by the method developed by the University of Toronto is acceptable to the local palate. The panelists did find that the colour of the tea was darker than expected. These results were consistent with observations made by Dr. Puri of the University of Delhi in tests with a typical Indian taste panel. This indicates that a broader human efficacy trial can be successfully performed, with consumer uptake of the iron fortified tea.

A larger scale efficacy test will help to determine whether this form iron fortification of tea will be effective and acceptable, or whether the colour difference will have to be addressed by encapsulating the iron, thus preventing any interactions with the tea until the iron fortificant system is digested. Work on microencapsulation of the iron has been initiated.

Author Contributions

LLD Procured funding, edited the final manuscript. P.F.M was involved in the planning, financial supervision and regular review of the program and E.M was charge of the day-to-day detailed operation of this project.

Competing interests: All authors have no competing interests.

Role of the funding source

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