

IRON CONTENT OF FOOD COOKED IN IRON UTENSILS: A TRADITIONAL INDIAN WAY*Bibifatima Bawakhan¹, Chandrashekar Veerappa Kubihal², Chandru M. C³*¹Postgraduate, Department of Biochemistry, Karnataka Institute of Medical Sciences, Hubli.²Associate Professor, Department of Biochemistry, Karnataka Institute of Medical Sciences, Hubli.³Professor & Head, Department of Biochemistry, Karnataka Institute of Medical Sciences, Hubli.**ABSTRACT****BACKGROUND**

Since most of the Indian population depends on vegetarian diet, prevalence of iron deficiency status is higher in India compared to other developing countries. In spite of many national programs and treatment options available in correcting this, the incidence is increasing due to poor patient compliance and intolerance to treatment. This study was an effort to show how iron content of Indian food can be increased just by following the traditional way of cooking.

OBJECTIVE

To compare the iron levels in the Jowar roti cooked in iron and non-iron utensils.

METHODOLOGY

A cross-sectional study was conducted at KIMS, Hubli. Jowar rotis were prepared from equal quantity of jowar flour in iron and non-iron tawa. Another sample of roti was prepared in iron tawa after treating with lemon juice. Six samples were homogenised and filtered. The filtrates were replicated and analysed for iron levels by FerroZine method.

RESULTS

In the present study, we found no change in iron levels in the roti prepared in non-iron utensil, 1.45 and 1.94 fold increase in the roti prepared in new iron tawa without water boiled in it and with water boiled in it for dough preparation respectively when compared with iron levels of plain jowar flour. There was 5.77 fold rise in iron levels in lemon juice treated roti which signifies the bioavailability of iron in food. The study showed statistical significance at 'p'- value < 0.05.

CONCLUSION

Several studies have shown the similar results and this was done to strengthen the findings in our staple food. Hence, the daily iron requirement can be met easily and effectively by taking the food cooked with lemon juice in iron utensils.

KEYWORDS

Bioavailability, Iron Deficiency Status, Iron Tawa, Jowar Roti, Lemon Juice.

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INTRODUCTION: Anaemia is a major global health problem, especially in developing countries like India. WHO defines anaemia as a condition in which the haemoglobin (Hb) content of blood is lower than normal for the person's age/sex.^[1] This may be due to deficiency of one or more essential nutrients regardless of the cause of such deficiencies, infections, inherited or acquired disorders that affect Hb synthesis, red blood cell production and survival.^[2] Globally, anaemia affects 1.62 billion people, which corresponds to 24.8% of the population.^[3] The highest prevalence is in children (42.6%) and the lowest prevalence is in non-pregnant women (29%). However, the population group with the greatest number of individuals affected is pregnant women (38.2%).^[2] Iron deficiency status is the most prevalent nutritional deficiency disorder in the world affecting all ages and social strata.

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It is caused mostly by inadequate intake and poor availability. Others are increase demand, chronic blood loss or child bearing.^[3] There are two forms of dietary iron, haeme iron and non-haeme iron. Haeme iron is found in meat, while non-haeme iron is in plants. Haeme iron is part of the haeme molecule, a compound of the porphyrin class that forms the non-protein part of haemoglobin, myoglobin, and some other biological molecules like cytochromes, catalase, tryptophan pyrrolase and nitric oxide synthase. Non-haeme iron proteins are transferrin, ferritin, hemosiderin and enzymes like ribonucleotide reductase which are also involved in a number of redox reactions. Most non-haeme iron is Fe³⁺ that must be reduced to Fe²⁺ before it can be absorbed.^[4]

Hydrochloric acid and pepsin are used to release non-haeme iron from food. In the presence of duodenal cytochrome reductase B (DCyTB) or ferric reductase, an enzyme present on the surface of enterocytes ferric iron is reduced to ferrous iron. This Fe²⁺ is transported into the intestinal mucosal cells by divalent metal transporter (DMT-1). Inside the cell, iron is oxidised to ferric state and is

complexed with apoferritin to form a temporary storage form, Ferritin.

A protein called transferrin then binds and transports iron from the digestive system to the bloodstream.^[5] While iron is absolutely essential for life, it is also extremely toxic. Free iron can generate dangerous free radicals through the Fenton reaction and free iron in the circulation can support the growth of microbial pathogens and increase the risk of systemic infections. Thus, iron is sequestered in the cell by ferritin and in the bloodstream by transferrin.^[5] In typical Indian diet, major quantity of iron is received from cereals since it is taken in bulk, although it contains lesser to moderate amount of iron. Another aspect is recommended daily allowance of iron is more for an Indian adult (~ 20 mg) when compared to western countries as the diet contains inhibitory substances like phytates and oxalates.^[6] So with this diet containing both moderate amount and inhibitors, still one can be away from iron deficiency status just by enhancing the bioavailability of iron in our staple food as a preliminary step in the correction of deficiency status.

The incidence of iron deficiency status is increasing in recent days in spite of better affordability for various food stuff. Many national programs and treatment options are failing to correct this due to poor patient compliance. Although the field research is involved in assessing the intervention under different settings, laboratory studies are also required to see whether, and to what extent, iron is leached from iron utensils. Hence, the present study was an effort to show how iron content of Indian food can be increased just by following the traditional way of cooking.

OBJECTIVES: To estimate and compare the iron levels in the jowar roti cooked in iron and non-iron utensils.

MATERIALS AND METHODS: A cross-sectional study was done at Karnataka Institution of Medical Sciences, Hubli after taking ethical clearance. Since jowar (Sorghum) is the staple diet in North Karnataka, jowar roti was prepared in three different utensils i.e. non-iron tawa, old iron tawa and new iron tawa. For non-iron tawa, Teflon coated non-stick tawa was used. Initially six samples of plain jowar flour (Atta) was weighed about 20 grams each. Hot water boiled in some other non-iron utensil was used to prepare the dough for making the roti in non-iron, old iron and new iron tawa. Hot water was boiled in new iron tawa to prepare the dough for making roti in new iron tawa itself. Another hot water boiled in new iron tawa which was pre-treated with lemon juice was used to prepare the dough to make the roti in new iron tawa. And one sample of plain jowar flour was used for comparison. For roti with lemon juice, initially a slice of lemon was cut and its juice was added to the water in new iron tawa, allowed to stand for 5 minutes and then the water was boiled for the dough preparation. The lemon juice used weighed 2.18 g which contains 1.15 mg of vitamin C in it.



Figure A: Preparation of Jowar Roti in Different Settings

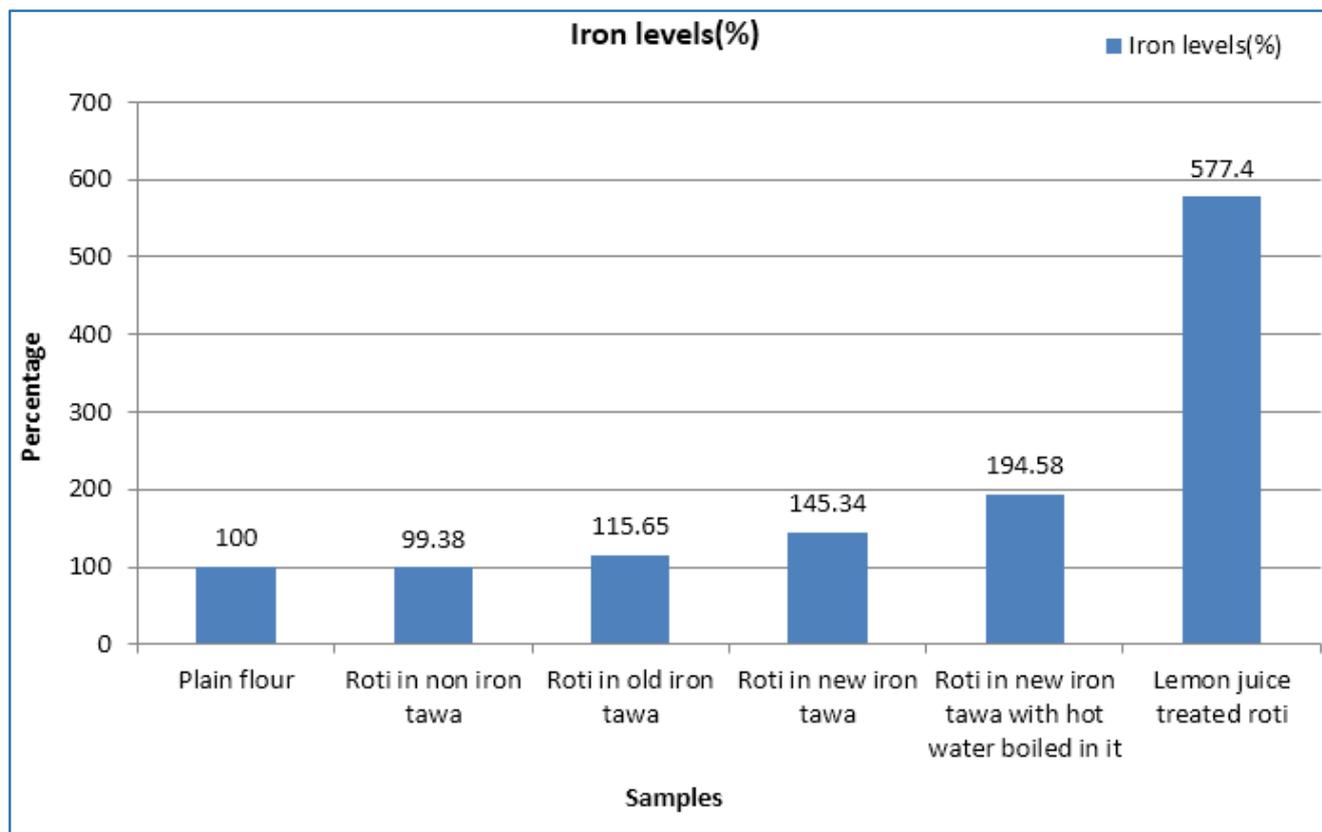
For homogenisation, 5 grams of sample was added to 10 mL of 2 M HCl and 10 mL of distilled water.^[7,8] Homogenates filtered and filtrates were replicated. These were estimated for iron levels by FerroZine colorimetric method in automation.

Statistical test: Results were expressed as mean±standard deviation. Statistical analysis was done using IBM SPSS software version 19. Mean value of replicated batches was used for comparison and expressed as percentage. One way ANOVA test (Analysis of variance) was applied to compare between and within the groups. The probability value p <0.05 was considered statistically significant.

RESULTS: The value obtained for per 5 gram of roti was reduced for per gram and the iron level is being expressed as µg/g of roti.

Sl. No.	Samples	Mean±SD (µg/g)	Percentage (%)
1.	Plain jowar flour	23.648±0.379	100
2.	Roti in non-iron tawa	23.503±3.039	99.38
3.	Roti in old iron tawa	27.35±1.142	115.65
4.	Roti in new iron tawa	34.372±1.332	145.34
5.	Roti in new iron tawa with hot water boiled in it	46.017±5.669	194.58
6.	Roti in new iron tawa with pre-treated lemon juice hot water boiled in it	136.545±2.515	577.40

Table A: Iron Levels and Its Percentage in Comparison With Plain Atta



Graph A: Iron Level of Samples in Percentage

	Degrees of freedom	Sum of squares	Mean sum of squares	F value
Between Groups	6-1= 5	40523.7	8104.74	1119.44
Within Groups	12-6= 6	43.46	7.24	
Total Groups	12-1= 11	40567.17	3687.92	

Table B: One way ANOVA test

One way ANOVA test (Analysis of variance) was applied for the samples and it showed highly significant difference between the groups at $p < 0.01$ ($F_{cal} > F_{tab}$). Within the groups, Tukey’s Post-hoc test showed statistically significant difference between lemon juice treated roti (26.24) and plain flour (112.9), non-iron tawa (113.05), old tawa (109.2), new tawa (101.98) and new tawa with hot water boiled in it (90.53). This signifies significant difference within the group with respect to lemon juice treated roti.

DISCUSSION: In the present study, we found no change in iron levels in the jowar roti prepared in non-iron utensil when compared to plain flour. Significant changes were noticed in iron values when food prepared in both old and new tawa (1.15 and 1.45 fold). Roti prepared in new iron tawa with hot water boiled in it showed 194.58% rise in iron level (1.94 fold). When treated with lemon juice it showed a dramatic increase in the value (577%) with 5.77 fold rise in iron levels (Refer Graph A). We also found the significant difference between lemon juice treated roti and rest of the rotis prepared in different settings which signifies the bioavailability of iron in the food (Refer table B). The study was similar to the results found by Adish et al^[9] Brittin and

Nossaman,^[10] Geerligs et al^[11] Kollipara and Brittin,^[12] Liu et al^[13] Park and Brittin^[14]

Tripp et al^[15] in their studies, where iron was leached from iron cooking equipment in a greater quantity. Studies by Borigato and Martinez,^[16] Cheng and Brittin^[17] showed improvement in haemoglobin levels in the subjects by consuming food cooked in iron pots over a period of time. Iron leached from iron cooking equipment is bioavailable to humans and rodents.^[18] Charles CV et al in their study found with the use of ingot the iron content was more in lemon water and acidity of food was positively associated with iron leaching.^[19] The concept of using the lemon juice is to maximise iron leaching from iron utensils and also food acidification with ascorbic acid enhances iron absorption by reducing ferric to ferrous iron, a soluble form.^[20] Many national programs and available treatment options are failing to reduce the prevalence of iron deficiency status due to poor patient compliance in terms of intolerance to drugs.

Indian diet especially vegetables though rich in iron content (Non-haeme iron) lacks its absorption due to inhibitors like phytates and oxalates, can still be consumed with soluble and bioavailable iron by using lemon juice which is naturally present at low cost. This study was an attempt to bring back the traditional way of food preparations in iron

utensils so that iron deficiency is minimised in all age groups with its good bioavailability.

Despite this advantage, iron cooking equipment is generally not well accepted because it is prone to rust, heavier, more difficult to clean and of poorer manufacturing quality than other pots/cook wares and food left in the pot overnight is perceived to change in taste and appearance.^[11,14] Since the advantage overcomes the deficiency status, the food cooked in iron vessels can be consumed and in limited proportions thereby to avoid toxicity. Also proper handling of iron utensils must be considered for the benefit of well-being. The effect of food supplementation treated with lemon juice cooked in iron vessels can be studied in anaemic individuals in future.

CONCLUSION: Thus, the daily iron requirement can be met easily and effectively just by consuming the food cooked with lemon juice in iron utensils.

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