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RESEARCH ARTICLE

Evaluation of efficacy of jaggery and raisins as supplements in iron deficiency anemia among medical undergraduate students in South India

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ABSTRACT

Background: Anemia is defined as a reduction of the total circulating red cell mass and is a major public health problem in India. More than 1.6 billion anemic people have manifestations of iron deficiency anemia (IDA). The best and most sustainable strategy for preventing micronutrient (iron and folic acid) deficiency is dietary supplement. Adolescent age group is the window of opportunity to correct their nutritional status by providing additional food supplements and prevent future consequences of nutritional deficiencies. **Aims and Objectives:** This study aims to evaluate the effectiveness of jaggery and raisins as supplements in treating iron deficiency anemia. **Materials and Methods:** This is a prospective interventional clinical endpoint study conducted among 50 female medical undergraduate students. They randomly received oral nutritional supplement (jaggery balls - 5 g and raisins - 5 g) once daily in the morning for 8 weeks. Body weight and complete blood count were assessed before and at the end of 8 weeks of intervention. **Results:** After 8 weeks of daily supplementation of jaggery and raisins, we observed that there was a significant rise in the mean hemoglobin (Hb) level to 11.79 ± 1.07 ($P < 0.0001$) and also a significant rise in the mean red blood cell count to 4.22 ± 0.30 ($P < 0.0001$) compared to baseline values. **Conclusion:** The outcome of this study proved the effective role of the nutritional supplementation in improving the Hb status in IDA. Combination of jaggery with raisins proved to be a better natural food supplement to overcome IDA without prominent side effects as observed with oral and parenteral iron preparations. It can also be used as a prophylactic strategy to combat iron deficiency in vulnerable population.

KEY WORDS: Iron Deficiency Anemia; Undergraduate Students; Jaggery; Raisins

INTRODUCTION

Anemia is defined as a reduction of the total circulating red cell mass below normal limits. Anemia reduces the oxygen-carrying capacity of the blood, thereby causing tissue hypoxia and paves the way for multiorgan damage.[1] Iron deficiency is one of the most common causes of anemia worldwide. More than 1.6 billion people who are anemic have manifestations of iron deficiency anemia (IDA).[2,3] 30%–50% of anemia in children and adults is caused by deficiency of iron and the prevalence of IDA is more in female than male.[1] IDA occurs due to inadequate intake of iron-rich products, chronic blood loss, or a combination of both. Dietary iron occurs in two forms: Heme and non-heme forms. The primary sources of heme iron are hemoglobin (Hb) and myoglobin which is obtained from consumption of meat, poultry, and fish, whereas non-heme iron is obtained from cereals, pulses, legumes, jaggery, fruits, and vegetable. Ascorbate and citrate

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increase iron uptake, by acting as weak chelators to help to solubilize the metal in the duodenum and enhance iron absorption.[4]

Anemia is classified based on the Hb levels as follows: Severe - <7 g/dl, moderate - 7–9.9 g/dl, and mild - 10–11.9 g/dl (10–10.9 g/dl for pregnant women).[5] Commonly used treatment for IDA is oral iron preparations. These preparations vary in their iron content as well as their own side effects.[6]

The best and most sustainable strategy for preventing micronutrient (iron and folic acid) deficiency is dietary improvement. Dietary changes can also act as a complement to pharmacological therapy, by providing additional nutrients and preventing adverse interactions between dietary supplements and food. Despite efforts to raise awareness of the need for dietary changes in these patients, many are not aware of the food products that are really effective in correcting anemia.[7] Henceforth, we are in need of better natural food supplements or food fortification[8] as an alternative or add-on therapy to oral iron preparations which can be used in case of mild anemic patients and also as a prophylactic strategy to overcome IDA at a cheaper cost and with good compliance, without causing any side effects.

Adolescent age is the perfect period to correct the nutritional status. If intervention is done correctly during this period, then future consequences of nutritional deficiencies can be prevented to a large extent. Consumption of mola (nutrient rich, small fish found in ponds, and rice fields in Bangladesh) had potential effect on iron status in children.[9] Carboadeim (combination of carrots, baobab, and godeim) is another naturally available and cost-effective hematinic blend that has been used as a supplement in the treatment of nutritional anemia in children.[10]

Recent study in India had shown that decreased intake of jaggery is one among the major factors contributing to IDA.[11] India is one of the largest producers of sugarcane. Of total sugarcane produced in India, 53% is processed into white sugar, 36% into jaggery and khandsari, 3% for chewing as cane juice, and 8% as seed cane.[11] Jaggery is very rich in important minerals, vitamins, and proteins. There were no Indian or International studies which have evaluated the effect of jaggery as food supplements in treating IDA among adolescent female college students.

Various studies have found that both pregnant and non-pregnant women are more vulnerable to develop IDA, which prompted us to undertake this study.[3,10] Furthermore, community-based interventions by means of effective communication help in improving anemic status in pregnant women.[12] Furthermore, studies have highlighted that immunity, especially cellular immunity, is influenced by nutritional anemia.[13] Hence, IDA, though an age-old concern in developing countries like India, still there is lack of awareness and lack of proper guidance regarding the nutritional supplements and the treatment modalities for the same. IDA is routinely managed by administration of different iron and folic acid preparations along with supplementation of iron-rich food sources. In this study, we tried to assess the effect of food product available abundantly and consumed widely. We observed during the anemia screening program in our institute that 96% of the female medical undergraduate students had Hb levels in subnormal range which corroborated with the finding of some other studies.[10] Henceforth, this study was planned among medical undergraduate students with IDA by supplementing jaggery and raisins.

Objective

Primary objective

The primary objective of this study was as follows:

- To evaluate the effectiveness of jaggery and raisins as supplements among the medical undergraduate students with IDA.
- To assess the mean change in the Hb levels after 8 weeks of supplementation among them.

Secondary objective

- To compare the mean change in the red cell indices (red blood cell [RBC] count, mean corpuscular volume [MCV], mean corpuscular hemoglobin [MCH], and MCH concentration [MCHC]) from the baseline up to 8 weeks of intervention period.

MATERIALS AND METHODS

This was a prospective interventional clinical endpoint study conducted among 50 female medical undergraduate students with IDA between February 2017 and September 2017 in a tertiary care teaching hospital, Puducherry. Female medical undergraduate students in the age group of 18–25 years having mild anemia with a Hb of 10 to <12 g/dl and having a peripheral smear picture of hypochromic, microcytic anemia were included in the study. Students with medical history of current hematological disorders other than IDA (e.g. aplastic anemia, megaloblastic anemia, sideroblastic anemia, pernicious anemia, thalassemia, and sickle cell anemia), thyroid dysfunction, chronic renal disease, menstrual irregularities, malabsorption syndrome, hypersensitivity to iron, or any of the components of the iron tablet and with history of prior intake of iron supplements 3 months before participating in the study were excluded from the study. All the students who fulfilled the inclusion and exclusion criteria were recruited for this study after getting a written informed consent from them. Convenient sampling method was adopted. The study was approved by the Scientific Research Committee and Institutional Ethics Committee of Sri Venkateshwaraa Medical College Hospital and Research

Centre (IEC No: IEC/2017/11). Confidentiality was maintained throughout the study. The study was funded by Indian Council of Medical Research.

The baseline characteristics such as age and body weight were recorded before administering the supplement. 5 ml of venous blood was collected under aseptic precautions in Vacutainer containing EDTA for the estimation of complete blood count and peripheral smear. Complete blood count was done by autoanalyzer - Mindray M52. The selected 50 female undergraduate students received oral nutritional supplement (jaggery balls - 5 g and raisins - 5 g), once daily in the morning, after 3 h of breakfast at 11.00 am for 8 weeks. The composition and food value of jaggery balls and raisins are mentioned in Tables 1 and 2. Figure 1 portrays the jaggery balls and raisins used in this study. Milk and milk products were restricted for a period of 1 h postadministration. The students were followed up for 8 weeks duration, and at the end of the study period, the body weight and complete blood count were repeated to assess the mean change in the blood parameters.

Statistical Analysis

Quantitative data (age, Hb, RBC count, etc.) collected were presented with mean and standard deviation. Paired Student's t-test was used to analyze the significant difference between the pre- and post-treatment Hb levels, RBC count, and red cell indices. Data were analyzed using GraphPad Prism software version 7.0. $P < 0.05$ was considered as statistically significant.

RESULTS

In this study, 50 female medical students who satisfied the inclusion and exclusion criteria were recruited and all of them completed the study procedure. It was observed during screening that the Hb levels were below the normal range in 96% of medical students. Table 3 shows the baseline demographic data.

The mean baseline Hb level was 11.35 ± 1.13. After 8 weeks of daily supplementation of jaggery and raisins, we observed that there was a significant rise in the mean Hb level to 11.79 ± 1.07 ($P < 0.0001$). The percentage improvement in the Hb levels after intervention was 4.1% [Tables 4 and 5]. The percentage improvement was calculated using the formula;

Improvement (%)=[(Hemoglobin after treatment–Baseline Hemoglobin)×100]/Baseline Hemoglobin

Of the 50 students, six had mild non-significant fall in blood Hb levels after 8 weeks of treatment and four had no change in Hb level, whereas other 40 medical students showed a significant increase in the Hb levels.

Statistically significant increase ($P < 0.0001$) in the mean RBC count was also observed after 8 weeks of daily

Table 1: Composition and food value of jaggery balls

Jaggery content	Proportion per 10 g
Calcium	8 mg
Iron	0.3 mg
Magnesium	16 mg
Potassium	13 mg
Carbohydrates	9.8 g
Calories	40

Table 2: Composition and food value of raisins

Raisin content	Proportion per 10 g
Vitamin C	0.23 mg
Iron	0.187 mg
Carbohydrate	7.9 g
Potassium	75 mg
Calories	29.88

Table 3: Demographic details (n=50)

Parameters	Mean±SD
Age	19.3±0.65 years
Body weight	56.5±5.45 kg

Figure 1: Jaggery balls and raisins

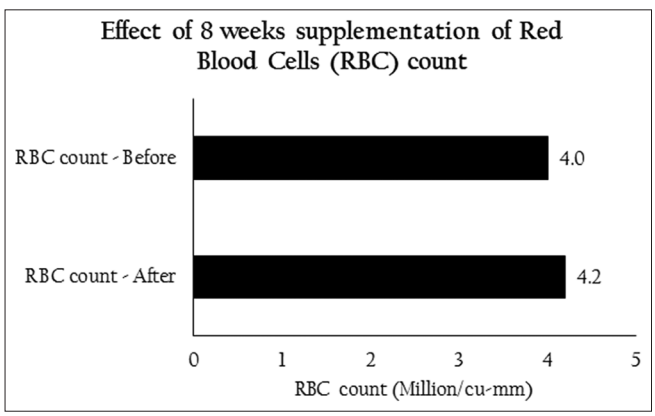

Figure 2: Comparison of pre- and post-supplementation - red blood cell count

supplementation [Figure 2]. The percentage improvement in the RBC count after the intervention was 5.64% [Table 5]. The percentage improvement was calculated using the formula;

Improvement (%)=[(RBC count after treatment-Baseline RBC count)×100]/Baseline RBC count

However, no significant improvement in the MCV, MCH, and MCHC values after 8 weeks of supplementation [Table 6]. There were no documented adverse effects during the entire study period.

DISCUSSION

In this study, we observed a significant increase in the Hb level and RBC count after 8 weeks of supplementation with jaggery and raisins among medical undergraduate students with no significant improvement in the MCV, MCH, and MCHC. There were also no documented adverse effects during the entire study period.

Similar observations were noted in other studies in which sugarcane molasses, fish, iron-fortified rice, and other iron-fortified supplements were used to overcome IDA.[10-17] A study done in Brazil among preschool children aged 2–3 years it was observed that consumption of jaggery as a sweetener in fruit juices for 12 weeks significantly increases the Hb and hematocrit level.[18] Similarly, children in rural areas of Shimoga, Karnataka, were supplemented with iron-fortified biscuits achieved significant increase in the mean Hb level.[15] Significant improvement in Hb level after 3–6 months intervention with food supplements was also demonstrated by Siva *et al*. and Mohamed Ali *et al*.[10,14] However, in the present study, we noticed a significant improvement in the Hb levels with 8 weeks of daily intervention with jaggery and raisins. Although iron deficiency is attempted to treat by various supplementations, jaggery could be a cost-effective alternative in developing country like India. A study conducted by Jain *et al*. showed that molasses contains iron and other nutrients such as sulfur, fructose, and copper which increases the iron absorption making it very good dietary supplement for IDA.[14] Similarly, jaggery and raisins apart from iron also contain ascorbic acid (Vitamin C) which is an iron absorption enhancer. A study conducted by Sachdev *et al*. showed preventing childhood anemia by routine addition of multi micronutrients to iron-folate supplementation appears unjustified currently.[19] However, our supplement (jaggery and raisins) can very well be advised, as the jaggery balls are edible sweet substance and can be consumed by both school-going children and adults. Iron supplements (tablets, capsules, and syrup) reduce the prevalence of IDA but reported increase in the risk of side effects such as constipation and abdominal pain.[20] There was no adverse effect associated with intake of jaggery in our study population, and this might improve the compliance among the people.

The small number of participants may partially limit the significant findings of this study and larger studies are required to enforce these original results. More research, product development, and evidence of safety and efficacy of jaggery and raisins in IDA management can provide tasty and cost-effective dietary supplement, particularly for children. In addition, there are few challenges to be faced,

Table 4: Comparison of pre- and post-supplementation Hb levels (*n*=50)

Pre-supplementation Hb (g/dl) (mean±SD)	Post-supplementation Hb (g/dl) (mean±SD)	Percentage improvement of Hb	*P* value
11.35±1.13	11.79±1.07	4.1%	0.0001*

Analysis was done using two-tailed paired Student's *t*-test (*<0.0001). Hb: Hemoglobin

Table 5: Comparison of pre- and post-supplementation RBC count (*n*=50)

Pre-supplementation RBC count (millions/mm^3) (mean±SD)	Post-supplementation RBC count (millions/mm^3) (mean±SD)	Percentage improvement of RBC count	*P* value
4.0±0.37	4.2±0.30	5.64%	0.0001*

Analysis was done using two-tailed paired Student's *t*-test (*<0.0001). RBC: Red blood cell

Table 6: Estimation of red cell indices (MCV, MCH, and MCHC) pre- and post-supplementation

Red cell Indices	Pre-supplementation (mean±SD)	Post-supplementation (mean±SD)	*P* value
MCV	84.5±4.62 (fl)	87.8±7.14 (fl)	0.7
MCH	28.2±0.89 (pg)	29.1±0.26 (pg)	0.7
MCHC	33.2±1.38 (%)	33.6±0.78 (%)	0.7

Analysis was done using two-tailed paired Student's *t*-test (*P*>0.05 non-significant). MCV: Mean corpuscular volume, MCH: Mean corpuscular hemoglobin, MCHC: Mean corpuscular hemoglobin concentration

such as competition for raw material from refined jaggery manufacturers, and quality control that need to be overcome.

CONCLUSION

The outcome of this study proved the effective role of the nutritional supplementation in improving the Hb status in IDA. Combination of jaggery with raisins proved to be a better natural food supplement to overcome IDA. The advantage of this preparation is that it does not have any significant adverse effects as observed with oral and parenteral iron preparations. It can also be used as a prophylactic strategy to combat iron deficiency in vulnerable population. Further studies can be planned to compare this nutritional supplement with oral iron therapy. Similar studies in school-going children with longer follow-up time, to evaluate the efficacy of this nutritional supplement is warranted.

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