Efficacy and Effectiveness Studies on Rice Fortification

Studies conducted in India

1. **Rice Fortification Pilot Study in Gadchiroli, Maharashtra, 2018 - 2020.**

   A study was conducted from 2018 to 2020 by TATA Trusts, with the support of Maharashtra state administration to assess the impact of Rice fortification in Gadchiroli district of Maharashtra, India on prevalence of anaemia in 104 women, adolescent girls and children. The rice fortification intervention was implemented for one year, through the public distribution system (PDS). The results showed reduction of 21.4%. in prevalence of anaemia among women, adolescent girls and children in the group that received fortified rice.

   Rice fortification pilot study in Gadchiroli, Maharashtra. Endline evaluation & impact assessment report. TATA Truts, 2020.

2. **Rice Fortification Study in School in Gujarat, 2018 - 2019.**

   A study was conducted among 973 children aged 6 to 12 year in Gujarat, India to evaluate the effect of a multiple micronutrient fortified rice intervention among school children through mid-day meal over 8 months. The study was carried out between June 2018 and February 2019. The fortified rice provided approximately 10% Recommended Dietary Allowance of iron; 25–33% of vitamin A, thiamine, niacin and vitamin B6; and 100% of folic acid and vitamin B12. The intervention significantly increased mean haemoglobin by 0.4 g/dL (p¼0.001), reduced anaemia prevalence by 10% ($p<0.00001$), and improved average cognitive scores by 11.3 points ($p<0.001$). Rice fortification can help address anaemia in settings where rice is a staple food.

   Mahapatra S, Parker ME, Dave N, Zobrist SC, Shajie Arul D, King A, Betigeri A, Sachdeva R. Micronutrient-fortified rice improves haemoglobin, anaemia prevalence and cognitive performance among schoolchildren in Gujarat, India: a case-control study. International Journal of Food Sciences and Nutrition. 2021 Jan 9:1-4.

3. Improving the Iron and Vitamin A status in Indian Schoolchildren, 2014

   The efficacy studies conducted for six months revealed a significant increase in Haemoglobin and serum ferritin and a significant decrease in total iron binding capacity in the subjects consumed iron-fortified rice. The **Increase in Hb concentration mean difference** was 17 **g/l.** In sensory evaluation the micronutrient fortified rice (after blending with natural rice in the ratio of 1: 100) was almost indistinguishable from natural rice after cooking except beta-carotene fortified rice which could not match the white colour of natural rice. The cost analysis revealed that cost to fortify rice can have a very small impact on rice consumption. From the

present study, it can be concluded that providing micronutrient fortified rice in school feeding programme could reduce the large burden of ID, IDA and VAD among children in developing countries.

Hussain, S.Z., Singh, B. and Rather, A.H., 2014. Efficacy of micronutrient fortified extruded rice in improving the iron and vitamin A status in Indian schoolchildren. International Journal of Agriculture and Food Science Technology, 5(3), pp.227-238.

4. Multiple Micronutrient Fortified Rice in School in Bangalore, Karnataka, 2010.

A study was conducted among 258 children aged 6 to 12 year in Bangalore, India to determine the efficacy of extruded rice grains fortified with multiple micronutrients. The study was carried out between July 2009 and March 2010. The results showed that after 6 months, plasma vitamin B-12 and homocysteine concentrations (both $P < 0.001$) as well as physical performance ($P < 0.05$) significantly improved in the group that consumed fortified rice. The B-12 levels increased from 266 pmol/L from baseline to 358 pmol/L by endline.

Thankachan P, Rah JH, Thomas T, Selvam S, Amalrajan V, Srinivasan K, Steiger G, Kurpad AV. Multiple micronutrient-fortified rice affects physical performance and plasma vitamin B-12 and homocysteine concentrations of Indian school children. The Journal of nutrition. 2012 May 1;142(5):846-52.

5. Fortified Rice in Franciscan School, Bangalore, Karnataka, 2005.

A study was conducted in Franciscan School, Bangalore, India on 184 children aged 6 to 13 year wherein dosage of 13 mg/day iron as micronized ground ferric pyrophosphate (MGFP) through fortified rice was administered for 7 months. The study period was August 2004 to April 2005. After 7 months of feeding, there was a significant increase in body iron stores and iron deficiency anemia decreased from 30% to 15% in the group that consumed fortified rice. Extruded rice fortified with MGFP fed in a school lunch meal increased iron stores and reduced the prevalence of iron deficiency in children.

Moretti D, Zimmermann MB, Muthayya S, Thankachan P, Lee TC, Kurpad AV, Hurrell RF. Extruded rice fortified with micronized ground ferric pyrophosphate reduces iron deficiency in Indian schoolchildren: a double-blind randomized controlled trial. The American Journal of Clinical Nutrition. 2006 Oct 1;84(4):822-9.

International studies

6. Fortified Rice in Public Child Day Care Centers, Brazil, 2013.

A study was conducted in Brazil on 171 children aged 10 to 23 months wherein dosage of 56.4 mg/day iron as ferric pyrophosphate through fortified rice was administered once per week for 18 weeks. The baseline mean haemoglobin in the groups that consumed fortified rice was 113.7 ± 9.2 g/L, and at endpoint 119.5 ± 7.7 g/L, ($p < 0.0001$, significant improvement). Anaemia prevalence in the group that consumed fortified rice was 27.8 % at baseline, and 11.1 % at endpoint, ($p = 0.012$). Rice fortified with iron given weekly was found to be effective in increasing haemoglobin levels and reducing anaemia in infants.

Arcanjo FP, Santos PR, Leite ÁJ, Mota FS, Segall SD. Rice fortified with iron given weekly increases hemoglobin levels and reduces anemia in infants: a community intervention trial. Int. J. Vitam. Nutr. Res. 2013;83(1):59-66.

7. Fortified Rice in Public Schools in Brazil, 2013.

A study was conducted in Brazil on 303 children aged 2 to 5 year wherein dosage of 56.4 mg/day iron as ferric pyrophosphate through fortified rice was administered once per week for 18 weeks. The baseline mean haemoglobin in the groups that consumed fortified rice was 12.06 ± 1.01 g/dL, and 12.14 ± 1.06 g/dL at endpoint. Anaemia prevalence in the groups that consumed fortified rice was 8.9% at baseline, and 10.5% at end of study. Considering only anaemic participants, there was a significant increase in haemoglobin means before and after intervention ($p=0.003$).

Placido F, Arcanjo N, Santos PR, Segall SD. Ferric pyrophosphate-fortified rice given once weekly does not increase hemoglobin levels in preschoolers. Rice Research: Open Access. 2013 Sep 19.

8. Fortified Rice in Child Day Care Centers, Brazil, 2012.

A study was conducted in Brazil on 216 children aged 10 to 23 months wherein dosage of 56.4 mg/day iron as ferric pyrophosphate through fortified rice was administered once per week for 18 weeks. The baseline mean haemoglobin in the group that consumed fortified rice was 11.44 ± 1.07 g/dl, and 11.67 ± 0.96 g/dl ($p < 0.029$) at the end of the study. Anaemia prevalence in intervention groups was 31.25% at baseline, and 18.75% at end of study ($p = 0.045$). Iron-fortified rice was effective in increasing haemoglobin levels and reducing anaemia in infants.

Nogueira Arcanjo FP, Roberto Santos P, Arcanjo CP, Amancio OM, Braga JA. Use of iron-fortified rice reduces anemia in infants. Journal of tropical pediatrics. 2012 Dec 1;58(6):475-80.

9. **Clinical impact study of micronutrients fortified rice for teen girls, Indonesia, 2016**

   About one third of women and teenagers in Indonesia suffering from anemia. The objective of this study was to develop a micronutrient fortified rice and to test its efficacy on reducing micronutrient deficiencies. The micronutrient fortified into rice included iron, zinc, folic acid, vitamin B1, vitamin B2 and vitamin A. The efficacy study was done through randomized control trial among 216 school teenage girls in Medan for fifteen weeks. The biomarker analyzed included hemoglobin, serum ferritin, serum vitamin A, serum zinc and folic acid. The results showed that fortified rice with 2% of rice kernel was accepted organoleptically. The increase in haemoglobin conc mean difference was 3.8 g/l.

   Hardinsyah, I., Briawan, D., Budianto, S., Hustina, P., Ghifari, N. and Suhandono, S., 2016. Production and clinical impact study of micronutrients fortified rice for teen girls in Islamic boarding school in Medan, Indonesia. Final report. West Java: Food and Nutrition Society of Indonesia (Perhizi Pangan Indonesia).

10. **Multiple Micronutrient Fortified Rice in School Lunch Program, Thailand, 2010.**

    A study was conducted in Thailand among 203 children aged 4-12 year to determine the impact of triple-fortified extruded rice (fortified with Iron, Zinc and vitamin A). The study was conducted from July 2009 to March 2010. Results showed significant increase of 11.3 ± 1.3 μmol/L ($P < 0.05$) in the serum zinc levels of the group that consumed fortified rice.

    Pinkaew S, Winichagoon P, Hurrell RF, Wegmuller R. Extruded rice grains fortified with zinc, iron, and vitamin A increase zinc status of Thai school children when incorporated into a school lunch program. The Journal of nutrition. 2013 Mar 1;143(3):362-8.

11. **Efficacy of Iron-fortified rice in infants and young children in Brazil, 2007-2008.**

    A study was conducted in Brazil on 175 children aged 6- to 24-months wherein dosage of 23.4mg/day iron through fortified rice was administered for 5 months. The study took place from October 2007 to February 2008. At 5 months, the Haemoglobin and Serum Ferritin levels improved significantly in the group that consumed fortified rice. The mean difference observed in Hb levels and SF levels was 10 ± 0.86 g/L and 4.3 ± 0.63 μg/L, respectively.

    Beinner MA, Velasquez-Meléndez G, Pessoa MC, Greiner T. Iron-fortified rice is as efficacious as supplemental iron drops in infants and young children. The Journal of nutrition. 2010 Jan 1;140(1):49-53.

12. **Efficacy of iron-fortified rice in reducing anaemia among schoolchildren, 2008.**

A study was conducted in Philippines on 180 anaemic children aged 6- to 9-year wherein dosage of 10mg/day FePP and Ferrous sulphate via fortified rice were administered for 5 days a week for 6 months The baseline prevalence of anaemia reduced by 49% and 46% in intervention groups that consumed iron-enriched rice (IER) with extruded iron premix rice (IPR) using ferrous sulfate as fortificant (ExFeSO4) and the group that received IER with extruded IPR using micronized dispersible ferric pyrophosphate (ExFeP80) respectively. Greater significant increases were also observed in plasma ferritin in the fortified groups than in the Control group from baseline to 6 months.

Angeles-Agdeppa, Capanzana, Barba, Florentino, Takanashi. Efficacy of iron-fortified rice in reducing anemia among schoolchildren in the Philippines. International journal for vitamin and nutrition research. 2008 Mar 1;78(2):74-86.

13. Efficacy of Iron-Fortified Rice in improving the iron status of women in Mexico, 2008.

A study was conducted in Mexico on 90 non pregnant, non-lactating women aged 18- to 49-year-old wherein dosage of 13mg/day iron through fortified rice was administered for 5 days per week for 6 months. In the group that consumed fortified rice, the absolute reduction observed in anaemia and iron deficiency was 10.3 and 15.1 percentage points, respectively. The overall prevalence of anaemia was reduced by 80%.

Hotz C, Porcayo M, Onofre G, García-Guerra A, Elliott T, Jankowski S, Greiner T. Efficacy of iron-fortified Ultra Rice in improving the iron status of women in Mexico. Food and Nutrition Bulletin. 2008 Jun;29(2):140-9.