Review article:

Considerations for Rice (Oryzasativa) Fortification with Essential Micronutrients in Public Health Intervention

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Abstract:

Background and Rationale: Fortification of staple foods and commonly used condiments with vitamins and minerals has been considered one of the most cost-effective interventions to prevent and control micronutrient deficiencies. Because of its wide local consumption, acceptability, reach, and quantum of consumption, rice (Oryzasativa) far exceeds the requirements of a staple food vehicle that can be considered for fortification purposes at a population-level intervention. The World Health Organization (WHO) has the mandate to develop evidence-informed guidelines for the fortification of staple foods as a public health intervention, including rice fortification with micronutrients. The WHO, in collaboration with the Global Alliance for Improved Nutrition (GAIN), convened a consultation on "Technical Considerations for Rice Fortification in Public Health" in Geneva, Switzerland in 2012 to provide technical inputs to the guideline development process, particularly with reference to feasibility and implementability. ***Conclusion:*** The industrial and regulatory technical considerations in rice fortification, as well as the considerations for implementing it as a public health strategy and assuring equitable access and universal coverage and priority research areas for the forthcoming years were reviewed in this article based on WHO consultation.

Keywords: Rice; Fortification; Micronutrients

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Background and consultation rationale

Fortification is the practice of deliberately increasing the content of essential micronutrients, such as vitamins and minerals, in food, seasonings, or condiments, so as to improve their nutritional quality. Because of its wide local consumption, acceptability, reach, and quantum of consumption, rice (Oryzasativa) far exceeds the requirements for adoption as a staple food vehicle for food fortification for the purposes of a population-level intervention.[1,2]. ln fact, five countries currently have legislation to fortify this cereal and many more are interested in doing so. As rice differs from other fortified food

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staples, such as maize or wheat, in that the grain is fortified directly rather than the subproducts. (e.g., flour or porridge), meeting such a mandate still entails overcoming some technological and technical barriers. Three main methods to fortify rice have been described to date: dusting, coating, and extrusion, which could be cold, warm, or hot.[3,4]

Rice is a highly culturally sensitive commodity. Growing, selecting, and cooking of rice grains are subject to regional, national, and even local preferences, which in turn affect, in different degrees, the micronutrient retention and the final amount of vitamins and minerals that will be consumed. A pending assignment in this area is to generate more data on the efficacy of this intervention in different contexts and for different nutrients and, furthermore, on its cost-effectiveness as public health intervention implemented at sub-national or national scale.[4,5]

The World Health Organization (WHO) is updating several evidence-informed guidelines for the fortification of staple foods as a public health intervention, including the fortification of rice with iron and other micronutrients. The WHO, in collaboration with the Global Alliance for Improved Nutrition (GAIN), convened a consultation on Technical Considerations for Rice Fortification in Public Health in Geneva, Switzerland, on October 9-10, 2012 to provide additional technical inputs to the guideline-development process, particularly in terms of feasibility and implementability. The objective of this consultation was to review the industrial and regulatory technical considerations in rice fortification, as well as the considerations for implementing it as a public health strategy and assuring equitable access and universal coverage.[5]

Rice production and consumption

Rice is the staple food for an estimated 3.5 billion people, making it the world's most consumed cereal after wheat. Rice milling removes B vitamins and minerals found the outer germ and bran layers. Twelve countries in Asia account for 90% of the world's total production. Rise is mostly eaten in the same country where it is produced; therefore the amount of rice that is traded internationally is small.[6]

Industrial processing worldwide and fortification technologies for rice

Type, production, nutrient losses and contents, industrial processes, extraction rate, and the implications for fortification were considered. Various processing methods are used in the food industry to manufacture rice products with desirable sensory quality on the basis of cultural and cooking preferences and nutritional considerations. The processes result in changes in the nutrient contents, stabilities, and retentions depending on the rice variety and the original nutritional quality.[7] currently used technologies include coating, dusting, and the various extrusion technologies. The main focus is on cold, warm, and hot extrusion technologies, including process flow, required facilities and sizes of operation. The advantages and disadvantages of the various processing methods including micronutrients with respect to their technical feasibility during processing, storage, washing, and various cooking methods and their physiological importance must be kept in mind.[4]

Stability and retention of micronutrients in fortified rice

Some investigators described some of their original work in assessing micronutrient retention in rice with different cooking processes. Differences in the production of rice premix affect the final amount of micronutrient consumed. Their study investigated the retention of vitamin A, iron, zinc, vitamin B12, and folic acid in six different rice premixes, used to prepare fortified rice cooked in five different ways. Considering retention and losses in cooking methods is important when planning a program and setting expectations on the nutritional impact on the target populations. Rice used in different regions in the world seems not to lead to a loss of most micronutrients with the exception of vitamin A. Factors involved in protecting vitamin A against losses during cooking of the rice need to be identified.[8]

Models for estimating nutrient fortification levels in rice

While different approaches can be used to estimate safe and efficacious amounts of key fortificants in rice and considerations in relation to stability, bioavailability, cost and diet given, proposed the use of WHO/FAO food fortification guidelines to decide which micronutrients to add and at what level. For rice fortification in public health, some investigators' rationale was to use iron, folic acid, vitamin B12, vitamin A, and zinc, at the same levels recommended for flours, but adding thiamin, vitamin B6 and niacin in order to cover the estimated average requirement for adults. It was argued that economic sustainability must be built into the entire supply chain and distribution net work and suggested to

adopt the experiences and lessons learned from rice fortification experiences of Costa Rica and the Philippines. [9,10,11]

Economic feasibility of industrially fortified rice in different contexts

The financial issues related to the implementation of rice-fortification programmes must be considered based on existing facilities, production, and considerations for implementation of fortified rice in countries with different levels of market development. Using the World Food Programme's pilot countries as sample cases, core cost elements included in the production of fortified rice kernels, transportation to the point of blending, blending of fortified with non-fortified rice, and quality control (QC) and quality assurance (QA), among other issues were described. In the early stages of implementation, implementers of the rice-fortification programme may face unforeseen additional costs related to the initiation of rice fortification.[11,12,13]

Considerations for rice fortification in public health

Legislation and policies

It is essential to explain the compatibility between the World Trade Organization (WTO) trade regulation and fortification legislation to national policymakers, so as not to delay the process of potential development of technical standards and mandatory legislation. The principles of the WTO can be found in the General Agreement on Tariff and Trade (GTT). According to them, there should not be any discrimination between trading partners, nor between imported and locally produced goods. have Countries to prove that the health measure is necessary and effective and that it does not represent an arbitrary discrimination. In order to comply with such regulations, it may be required to build on the data from different food and nutrition national surveys conducted in a representative sample of the population to identify the groups at risk of micronutrient deficiencies and their dietary intake, the availability of other fortified products and nutrition interventions aimed at improving the micronutrient intake and the use of rice for derivative products such as rice flour. [14]

A deep understanding of the regulatory environment and possible barriers to trade such as having a set of requirements not aligned to international standards is critical when deciding on rice fortification Programs as public health intervention. Standards need to list technical considerations, have broad stakeholder engagement, and keep in mind other fortification programs and nutrition interventions occurring simultaneously in the country. Countries implementing a fortification program may need support to capacitate technical staff of the regulatory agencies on this novel intervention to assure a high-quality, safe, and effective product that is acceptable to the consumer. Other staple foods, such as wheat flour, vegetable oil, sugar, salt and condiments are also increasingly being fortified with various micronutrients.[14,15,16]

Before legislating a desirable premix composition, it is therefore essential to have a holistic picture of every current or potential fortification and supplementation programme in order to avoid any micronutrient intake above the upper level tolerable limit for each vulnerable group consuming the fortified foods, particularly children. An additional consideration in this area is that the financial burden of fortification (mainly the fortificant) could and is usually divided among multiple food vehicles.[14,15]

Quality Control (QC) and Quality Assurance (QA) of fortified rice

The enactment of national standards and/or mandatory legislation on its own is not sufficient and requires a well-designed monitoring system for quality control and assurance. Enforcement is the most critical – and this not only for rice but also for all fortification programs of staple foods in public health. QA refers to the implementation of planned and systematic activities necessary to ensure that products or services meet quality standards. In the case of fortified rice produced locally, these activities may require assessment on kernels, premix, and final product. Separate requirements for the different technologies may be needed, as the operational procedures for one method may not be applicable to others. QC refers to the techniques and assessments used to document compliance of the product with established technical standards through the use of objective and measurable indicators. This may include the development of semi-quantitative or quantitative rapid test kits for the premix, as well as some fortified rice and the cooked rice (as it has been already developed for other fortification strategies). Once developed, support to countries implementing the fortification program will be needed to ensure that technical staff of the regulatory agencies is able to perform those tests and hence assure a high-quality, safe, and effective product that is acceptable to the consumer.[1,2,11]

Behavior-change communication

Strategies for behavior change communication can help to (1) understand knowledge of and attitudes toward fortification of this staple food from different quarters involved in the fortification program, not only from consumers; (2) identify crucial success factors and opportunities for the program; (3) choose best appropriate delivery channels according to target groups; (4) generate demand from different sectors; and (5) communicate other nutritional aspects related to rice fortification, e.g. household storing and use of rice. The establishment of a behavior-change intervention requires proper planning and budgeting to ensure there is an effect on a sustained manner.[16]

Programme monitoring and evaluation

Assuring effective monitoring of the implementation of the programme in its early stages and as it scales up is essential to assess whether good coverage and adherence to the intervention is achieved. The decision of whether to implement an evaluation, either an impact evaluation or another type, depends upon many factors and is context specific. It needs to be complemented with a logical framework and an indicators matrix. Monitoring indicators for measuring the potential of rice fortification to prevent micronutrient deficiencies and therefore increase the intake of nutrients should include (1) ongoing internal and external QC of the fortified rice available on the market, (2) coverage of the fortified rice, and (3) estimation of the daily consumption by target groups. There are several resources developed for other micronutrient interventions that can be adapted in a rice-fortification program.[15]

Research priorities on rice fortification

The key areas of research priorities for implementation to scaling up of rice fortification as a public health strategy were identified as the following: (i) stability of different micronutrients and compounds in different cooking processes that are context specific; (ii) relative bioavailability among different chemical forms of various micronutrients that can be used in rice fortification, including nutrient-nutrient interactions; (iii) acceptability of changes, if any, in organoleptic characteristics with different micronutrient combinations on different fortified rice preparations and cooking methods; (iv) effects of different phytate contents on the absorption of iron from the premix formulation; (v) most appropriate delivery platforms for reaching the intended target population; and (vi) effectiveness of different methods of fortification for rice in different contexts.[11,15,17]

Conclusions

There is no single best model appropriate to increase the micronutrient intakes for all population segments and strategies should not be mutually exclusive. It is imperative to combine different approaches to be able to penetrate most segments, if not all, of the population especially in countries where large sections of the population have relatively limited access to a nutritious and diverse diet. Rice fortification is a promising strategy for countries in which rice is a food staple. Decisions about which nutrients to add and in which amounts must be guided by the nutritional needs of the population, the rice consumption profile of the target groups, other programs already in place and their coverage (supplementation, fortification, and others) and the existence of proper delivery platforms. Behavior communication campaigns to generate demand and drive the development of appropriate policies are also needed. The governments or any agencies may make decisions on whether the use of locally or imported fortified rice is a feasible option to improve the diet and nutritional status of populations where vitamin and mineral deficiencies are still prevalent.

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Conflicts of interest

The authors declare no conflicts of interest.

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