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### Awareness, Perception, and Participation on Micronutrient Supplementation through Fortified Rice among the Service Providers of National Food Safety Act in Dhubri District of Assam, India

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#### Abstract

Micronutrient deficiencies are a major public health issue in India, especially among women and children. Fortified rice, enriched with essential micronutrients, offers a promising solution. This study assessed the awareness, perception, and participation of service providers in fortified rice programs in Dhubri district, Assam, India. A pre- and post-training assessment was conducted among government food safety program service providers, including Child Development Officers, ICDS Supervisors, BEEO, Nodal Teachers, and regular teachers. Training significantly improved their awareness and perception of fortified rice. Initially, most participants preferred normal rice over fortified rice regarding appearance, taste, and smell. Post-training, preference for fortified rice increased notably ( $p < 0.00$ ). Understanding of its nutritional benefits and its role in preventing anemia improved, along with positive shifts in opinions on government distribution policies. The KAP Index showed significant improvement in service provider's knowledge and awareness during pre and post training. These findings highlight the need for continuous awareness efforts and tailored educational materials to ensure the sustainable adoption of fortified rice programs and improve public health outcomes.

#### Keywords

Rice Fortification, Micronutrients, Anemia, Assam, Dhubri, Nutrition education, Health communication

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## Introduction

Micronutrient Deficiencies (MNDs) have emerged as a profound public health concern, affecting societies worldwide and transcending economic boundaries. These deficiencies strike vulnerable groups across demographics, leaving a significant mark on women, children, middle-aged people, and the elderly. Their pervasive influence on health problems, spanning from low-income nations to industrialized societies, implies the urgent need for intervention (Tulchinsky, 2010).

Hidden Hunger (Gödecke et al., 2018; World Health Organization, 2018), a significant public health concern has left its imprint on India's populace, particularly affecting women, and children. Its repercussions echo throughout the nation, necessitating decisive action to address this nutritional crisis. (Antony et al., 2022) The gravity of public health implications of micronutrient malnutrition cannot be overstated. Its relevance in devising strategies for combating diseases such as HIV/AIDS, malaria, tuberculosis, and diet-related chronic ailments is monumental (World Health Organization, 2018).

Food fortification is a pivotal and cost-effective approach aimed at enhancing the nutritional quality of staple foods and catering to extensive segments of the population. When implemented effectively, fortification serves as a straightforward and efficient method to augment crucial vitamins and minerals in diets (World Health Organization, 2018). This strategy holds profound importance for both developed and developing nations, ensuring that processed foods deliver essential nutrients that are vital for human sustenance (Tulchinsky, 2010).

Rice stands as a pivotal crop in global agriculture, particularly in Asia where 90% of the world's rice production occurs and is consumed. This cereal grain holds substantial dietary significance, contributing an average of 30% of total calorie intake across populations. Notably, in low-income countries, this percentage can surge to more than 70%, highlighting the paramount role of rice in these diets. Across numerous languages spoken in

these areas, the terms denoting "rice" and "food" are often synonymous. (Steiger et al., 2014) Its kernels provide an opportunity for enrichment with crucial micronutrients, such as iron, folic acid, B-complex vitamins, vitamin A, and zinc, some aimed at restoring intrinsic nutritional content pre-milling, while others are specifically intended for fortification purposes (Peña-Rosas et al., 2019). It was some common myths and misconceptions surrounding FRK which prevented its use at large scale. (L R et al., 2023).

Persistent public health concerns, such as the prevalence of iron deficiency anemia affecting over 50% of women aged 15–45 years and children under 5 years, remain significant in India. (National Family Health Survey India -5, 2021) Furthermore, 62% of the Indian population exhibit insufficient serum blood levels of crucial vitamins A and D, ranging from 50% to 94% (Aparna et al., 2018). This micronutrient deficiency contributes to adverse health outcomes, including stunting, heightened susceptibility to infectious ailments, physical impairment, cognitive deficits, visual impairment, and premature mortality.

Recent scientific research has highlighted a critical timeframe for preventing chronic malnutrition. Over the span of 1,000 days, from conception to the age of two, insufficient dietary intake, often coupled with frequent infections and inadequate care practices, leads to stunting (short length-for-age) and deficiencies in essential micronutrients. Stunting serves as an indicator that a child lacked proper nutrient intake and experienced micronutrient deficiencies during this crucial developmental period. It can also serve as a gauge for assessing the risk of inadequate micronutrient intake in the broader population (Black et al., 2008).

Fortifying rice offers a promising strategy to enhance the intake of essential vitamins and minerals among the general population, combating widespread micronutrient deficiencies (Kennedy et al., 2002). The success of fortification programs hinges on selecting the appropriate food vehicle, one that is consumed regularly, affordable,

appealing, and culturally acceptable. Furthermore, fortified foods must maintain their original characteristics and appearance while ensuring the stability of added nutrients under local storage and usage conditions (Piccoli et al., 2012). Rice stands out as an ideal candidate for fortification due to its widespread consumption, affordability, and availability. Recent advancements in technology enable the creation of fortified rice that closely resembles its nonfortified counterpart, thereby enhancing its potential acceptance.

As reflected in the National Nutrition Strategy of 2017, fortification as a complementary strategy has been integrated into the policy framework of the Government of India (GoI), as well as in several flagship healthcare programs and policies, including Anemia Mukt Bharat and POSHAN Abhiyaan 2.0. Rice fortification, given its widespread consumption by 70% of the population and its prominent role in government safety net programs such as the Public Distribution System (PDS), Anganwadi Services Scheme (AWS) and PM POSHAN, holds the highest potential among staple food fortification initiatives. 'Food Safety and Standards (Fortification of Foods) Regulation, 2018' stipulates the standard dosage for fortification of rice and other food items. Although these regulations exist, rice fortification in India remains suboptimal despite these provisions. The Government of India took a decisive step by approving the Centrally Sponsored Pilot Scheme

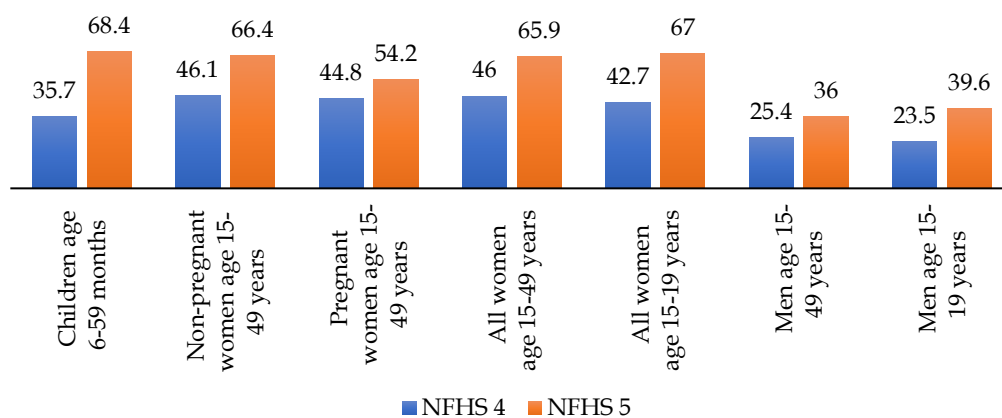
on "Fortification of Rice & its Distribution under Public Distribution System." This initiative, with a substantial budget allocation of Rs 174.64 Cr (USD \$21,248,780.49), signifies a proactive stride towards addressing nutritional deficiencies in the country (Ministry of Consumer Affairs, Food & Public Distribution, 2020).

In summary, rice fortification embodies a beacon of hope in the battle against micronutrient deficiency. It represents a proactive measure aimed at enriching the nutritional profile of staple foods, potentially impacting the health and well-being of millions across India. As this initiative gains momentum, it signifies a promising future wherein fortified rice plays a pivotal role in elevating public health standards and mitigating the subtle yet pervasive effects of Hidden Hunger.

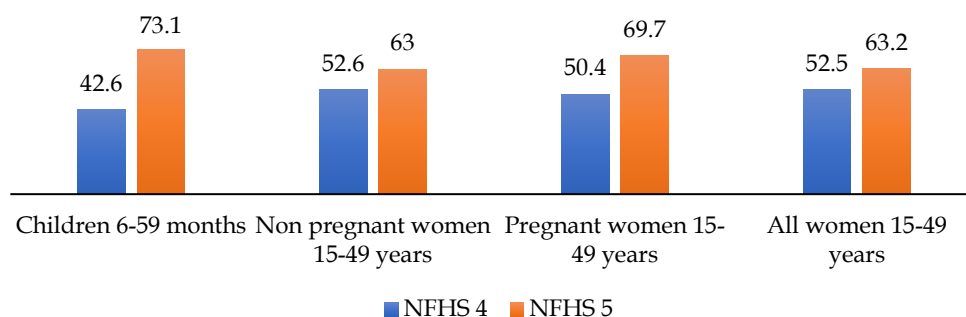
#### *Anemia in Assam*

Anemia rates in Assam are high among all sections of the population, according to the National Health Family Survey-5 (NHFS-5). The nutritional status of anemic children has also deteriorated significantly.

During National Family Health Survey (NFHS) 4 and 5, the proportion of anemic children and women has gone up in Assam creating an alarming situation. The increase in prevalence of anemia in Assam among different age groups, presented in Figure 1.



**Figure 1** Prevalence of Anemia among children, pregnant, non-pregnant women, and men in Assam as per NFHS 4 and 5



**Figure 2** Prevalence of Anemia among children, pregnant and non-pregnant women in Dhubri District of Assam as per NFHS 4 and 5

Multiple determinants of suboptimal child nutrition and development lead to poor nutritional outcomes in Dhubri district. Inadequacies in food, health, and care in Dhubri district contributed to high prevalence of anemia irrespective of age and sex. The severity worsens from NFHS 4 to NFHS 5. Figure 2 portrays the fact.

To reduce Anemia in target populations, the government of Assam piloted a centrally sponsored rice scheme in Dhubri district, one of Assam's aspirational areas.

#### *The intervention*

PATH provided technical support to the state government for expediting the rice fortification process. This involved aligning the supply chain, reinforcing the infrastructure of Fortified Rice Kernel (FRK) production and premix manufacturing, ensuring quality control and assurance, and establishing a robust monitoring and evaluation framework. This collaborative effort aimed to improve the capacity of key stakeholders, including the food industry, government officials, and frontline workers, to facilitate the implementation of rice fortification within the state. Furthermore, effort was also made to implement the health communication and awareness initiatives across relevant government programs, disseminating Information, Education, and Communication (IEC) guidelines to generate awareness in the state. One of the key objectives of this collaboration was to improve to facilitate evidence-based decision-making through rigorous

monitoring and review processes and ensuring the dissemination of evidence for broader impact and maintaining data quality across all levels. One of the other objectives of this collaborative effort was to create success stories in fortification and busting myths that can be institutionalized into the central system.

This paper intends to address the gap in understanding the perspectives of food safety service providers regarding fortified rice. While existing studies often focus on consumer perceptions, the viewpoints and understanding of these service providers remain unexplored. Their knowledge, awareness, and opinions regarding the use of fortified rice to combat nutrient deficiencies have not been adequately investigated. This paper aims to bridge this gap by delving into the insights of these stakeholders, aiming to enhance the implementation and effectiveness of fortified rice in addressing nutritional challenges in the region. More specifically, this paper will assess the level of awareness & perception of fortified rice and motivation of service providers of Safety Net Programs to supply fortified rice as per the National Food Safety Act in Dhubri district, Assam, India.

#### **Methodology**

##### *Area for the study*

The training of service provider was undertaken in Dhubri district of Assam. Dhubri is an aspirational district in the state of Assam, India. In February 2019, Dhubri ranked second in the state for health and nutrition, first in education in September and

October 2019, and second in basic infrastructure in September 2020 (Government of Assam, India, 2024) Dhubri presents a complex tapestry of demographic and nutritional challenges. The district covers an area of 2,176 Sq. Kms including forests, riverine islands, hills etc. It is one of the most densely populated districts in India with a density of 896 persons per Sq. Km. With a total population of 2104198 as per 2011 and a notable sex ratio of 1,000/1,000 females per 1,000 males, the district harbors a substantial number of women of reproductive age (557319), as also evident by the 58,457 pregnant women registered for ANC. There are approximately 2135 Anganwadi centers and nearly 1386 schools. However, despite the significant institutional births recorded at 29020, the nutritional landscape among children under five years and women aged 15-49 presents concerns. High rates of stunting, wasting, underweight, and anemia among children mirror the broader trends in malnutrition prevalent in the region, while the occurrence of overweight/obesity among both children and women signifies the coexistence of undernutrition and overnutrition challenges. Immediate determinants such as infant and young child feeding practices, as well as underlying determinants like education levels and access to sanitation, intersect to shape the nutritional outcomes observed (Singh et al., 2022).

Dhubri district is primarily dependent on agriculture and forest products. Main source of income is paddy with surplus production than its requirement. The total rice production is 15,000 Tones (Approx.) per year. But this value varies depending upon the weather & flood condition.

### ***Study Participants***

As part of the intervention, a three-day capacity enhancement workshop was organized during December 22-24, 2022, for the service provider in Dhubri district of Assam. The participants were nominated by the government and overall, 163 service providers participated in the workshop organized by technical partner to the state in collaboration with the state government. These

service providers were involved in government food safety schemes responsible for the distribution of fortified rice among the vulnerable sections of the community.

The breakup of service providers who participated in the training is given in the table below in Table 1.

### ***Indicators for Measurements***

A pre and post test was conducted among the participants to assess their knowledge retention. A structured questionnaire was administered during the beginning of the training and the same questionnaire was used at the end of the training. This questionnaire was designed to gather comprehensive information on the following aspects.

1. Awareness: Assessing the level of awareness regarding fortified rice, including its nutritional benefits and implications for the vulnerable community.
2. Perception: Exploring the subjective interpretations, attitudes, and beliefs of service providers concerning the efficacy, and benefits of fortified rice distribution.
3. Participation: Exploring the willingness to use fortified rice for themselves and promote it in the community.

Knowledge, Attitude and Practice (KAP) Index: The study created a KAP (Knowledge, Attitude, and Practice) Index with 19 questions. Each question was designed to assess participants' understanding, mindset, and behavioral tendencies regarding the subject under investigation. For each affirmative response provided by the participants, a score of 1 was allocated, while negative responses were assigned a score of 0. A composite score was generated with a minimum score of 4 and Maximum score of 22. The internal consistency of the items was checked by conducting reliability analysis which indicated high level of internal consistency with Cronbach Alpha score of 0.849.

**Table 1** Type of service providers who participated in the training and their cadre

Service Providers	N (%)	Cadre
Child Development Officer	15(9.2)	ICDS
ICDS Supervisor	80 (49.1)	ICDS
BEEO	1 (0.6)	Mid-Day Meal
Nodal Teacher	40 (24.5)	Mid-Day Meal
Teacher	27 (16.6)	Mid-Day Meal
<b>Total</b>	<b>163</b>	

The composite scores obtained were then stratified into distinct categories to facilitate a nuanced understanding of participants' responses. Scores falling within the range of 4 to 9 were indicative of a 'Low KAP Score,' suggesting potential gaps in knowledge, attitudes, or practices. Scores from 10 to 15 indicated a 'Moderate KAP Score,' signifying a moderate level of engagement and understanding. Scores ranging from 16 to 22 were classified as a 'High KAP Score,' indicative of a strong grasp of the subject matter and favorable attitudes and practices for the fortified rice.

#### **Data Collection Procedure**

Trained researchers administered the pre-tested questionnaire through in-person interviews or electronic surveys, ensuring consistency and accuracy in data collection. Prior informed consent was obtained from each participant before the questionnaire administration. Qualitative insights about the training were collected after the end of the training to assess how this training has helped them to develop better knowledge, perceptions and practice related to fortified rice.

#### **Data Analysis**

Quantitative data on levels of awareness, perception, knowledge, and practices were analyzed using SPSS 18.0 for statistical analysis such as descriptive statistics, frequencies, percentages, etc.

#### **Ethical Considerations**

This study adhered to ethical guidelines, ensuring confidentiality, voluntary participation, and informed consent from all participants. Approval was obtained from the relevant institutional review board before commencing the study.

## **Results**

### ***Perception of Fortified Rice among the Service providers***

Rice fortification involves the process of adding essential micronutrients such as vitamins and minerals to rice to improve its nutritional content. This is particularly important in regions where rice is a staple food and where nutritional deficiencies are prevalent. Service providers could include individuals working in food distribution, healthcare, nutrition, or related fields. The table below presents perception of service providers about Fortified Rice (FR).

Table 2 provides a comprehensive response before and after an intervention regarding perceptions of normal rice versus fortified rice. Initially, a significant majority of respondents preferred normal rice over fortified rice in terms of appearance, taste, and smell, with figures ranging from 72% to 83% favoring normal rice. However, post-training, there was a considerable increase in the preference for fortified rice across these sensory attributes, with percentages ranging from 17% to 32% ( $P < 0.001$ ) for appearance, 17% to 31% ( $P < 0.001$ ) for taste, and 21% to 29% ( $P < 0.001$ ) for smell. This suggests a marked improvement in participants' perception of fortified rice's sensory qualities following the intervention.

Moreover, there was a significant enhancement in participants' understanding of the nutritional value of fortified rice compared to normal rice. Before the training, only 30% of respondents believed fortified rice to be more nutritious than normal rice, while 33% considered their nutritive values equal. However, post-training, there was a substantial increase in the percentage of participants recognizing the nutritional superiority of fortified

rice, with 95% ( $P<0.001$ ) acknowledging its higher nutritional value compared to only 4% perceiving them as equal. This demonstrates a remarkable improvement in participants' awareness of the nutritional benefits offered by fortified rice.

Additionally, the post-training results indicated a shift in respondents' opinions regarding government distribution policies. Initially, 62% of participants opposed the government's supply of fortified rice and favored the distribution of general rice. However, post-training, there was a significant reversal in this sentiment, with 88% ( $P<0.001$ ) of respondents supporting the continuation of fortified rice distribution compared to only 12% advocating for a return to distributing general rice. This suggests a positive impact of the

intervention in influencing participants' views on rice fortification program. There was also a notable increase in participants' interest in learning more about fortified rice post-training, with 99% ( $P<0.001$ ) expressing a desire for further information compared to 96% before the intervention. This indicates a heightened curiosity and receptiveness among participants towards understanding the benefits and implications of fortified rice consumption. Regarding the question "Do you think the government should continue supplying fortified rice?" reveals a significant shift in participants' opinions. Prior to the training, 62% of the service provider dissented the government's distribution of fortified rice, while 38.0% ( $P<0.001$ ) favored a return to distributing general rice.

**Table 2** Perception of Fortified Rice among the participants

Indicators	Response category	Round of Interviews		Pearson Chi Square	Sig. (P Value)
		Pre-test (%) N=163	Post test (%) N=163		
Which rice looks good?	Normal rice	79.8	17.2	128.46	0.00
	Fortified Rice	9.8	31.9		
	Both are same	10.4	50.9		
Which rice tastes good?	Normal rice	83.4	17.2	143.12	0.00
	Fortified Rice	6.1	30.7		
	Both are same	10.4	52.1		
Which rice smells good?	Normal rice	72.4	20.9	87.66	0.00
	Fortified Rice	12.3	28.8		
	Both are same	15.3	50.3		
Which statement applies to you for fortified rice?	Fortified rice is nutritious than normal rice	30.1	94.5	144.28	0.00
	Nutritive value of fortified and normal rice is equal	33.1	3.7		
	Fortified rice dose not contains additional nutrients	36.8	1.8		
Would you like to know more about fortified rice?	Yes	95.7	99.4	4.61	0.03
	Not needed	4.3	.6		
	I know everything	0.0	0.0		
Do you know the benefits of Fortified Rice?	Prevents anemia	76.7	94.5	28.85	0.00
	Increases body weights	4.3	4.3		
	Reduce appetite	10.4	1.2		
	It is not healthy	8.6	0.0		
Does eating fortified rice improve people's health?	Do not have impact on health	0.0	0.0	41.65	0.00
	No	29.4	3.1		
Do you think the government should stop supplying fortified rice and resume distribution of general rice?	Yes	70.6	96.9	28.74	0.00
	No	62.0	87.7		
	Yes	38.0	12.3		

However, post-training, there was a substantial change in attitudes, with 88% ( $P < 0.001$ ) of participants supporting the continuation of fortified rice distribution, compared to only 12% advocating for distributing regular rice.

#### ***Qualitative insights from the service providers on perception of fortified rice***

Training played a pivotal role in shaping participants' attitudes towards rice fortification, leading to a notable positive shift in their perceptions. Initially, there existed a concern regarding the organoleptic /sensory attributes such as smell and taste of fortified rice. However, as participants engaged in training sessions and garnered knowledge about the process and benefits of fortification, their concerns dissipated. One participant summarized this transformation by acknowledging,

*"Earlier I thought the smell and taste and all will be different for this rice. But now I understand it is same as normal rice only."*

The journey from apprehension to acceptance was marked by the clarity provided through nutritional awareness/ education. Inconsistent information had initially led to confusion and doubts about the quality and consistency of fortified rice. Nevertheless, as individuals gained insights into the science behind fortification and its equivalence to regular rice, their trust began to solidify.

As one participant articulated,

*"There was a lot of confusion about the quality of the fortified rice, but, it got cleared."*

Despite initial reservations, participants exhibited openness to incorporating fortified rice into their diets, driven by an acknowledgment of its potential health benefits, particularly in addressing issues like anemia. Expressions of readiness to adopt fortified rice for family consumption underscored a shift towards embracing its utility.

As one participant affirmed, *"No, I haven't used fortified rice so far, but I am ready to cook it for my family, if provided."*

Another participant echoed this sentiment, stating, *"I understand how fortified rice can help with health outcomes; I want to use it."*

Moreover, participants expressed a genuine interest in examining deeper into the long-term implications of fortified rice consumption. As one participant said,

*"I'm curious to learn more about how fortified rice works and its long-term effects,"*

This underscores the significance of sustained engagement, nutrition literacy dissemination and learning initiatives in facilitating informed decision-making.

#### ***Awareness of FR among the service providers***

Awareness of rice fortification among service providers is essential to improve public health outcomes. Rice fortification involves the addition of essential micronutrients such as iron, folic acid, and vitamins to rice during processing, thereby enhancing its nutritional value. Service providers, including rice millers, distributors, retailers, and government agencies, play a critical role in ensuring the successful implementation of rice fortification programs. They need to be knowledgeable about the benefits of fortified rice, the appropriate fortification processes, quality and the regulatory standards governing fortified food products. And also, raising awareness among service providers helps to promote consumer acceptance and uptake of fortified rice, contributing to preventing nutrient deficiencies and promoting overall health and well-being in communities.

The results presented in Table 3 provide insights into the efficacy of the training at enhancing understanding and awareness regarding fortified rice and its nutritional significance. The findings suggest a substantial advancement in the participants' comprehension and recognition of key aspects related to fortified rice following training.



**Table 3** Awareness of FR among the participants

Indicators	Response category	Round of Interviews		Pearson Chi Square	Sig. (P Value)
		Pre-test (%) N=163	Post test (%) N=163		
What are the nutritional ingredients used in Fortified Rice?	Iron + Folic acid + Vitamin	2.5	11.7	66.20	0.00
	Iron + Salt + Vitamin	44.8	76.7		
	Only iron	10.4	2.5		
	Rice powder+ folic acid + vitamin B12	42.3	9.2		
Why should rice be fortified?	Improve nutritive value	78.5	98.2	31.80	0.00
	Improve taste	8.0	1.8		
	Reduce price	0.0	0.0		
	To produce rice in a laboratory	13.5	0.0		
Do you know the benefits of Fortified Rice?	Prevents anemia	76.7	94.5	28.8	0.00
	Increases body weights	4.3	4.3		
	Reduce appetite	10.4	1.2		
	It is not healthy	8.6	0.0		
Does eating fortified rice improve people's health?	No	29.4	3.1	41.6	0.00
	Yes	70.6	96.9		
Which of the following symbols means fortification?	F	59.5	95.1	59.12	0.00
	B	18.4	3.1		
	P	22.1	1.8		
What are the schemes that the government provides fortified rice? (Open Market)	No	0.0	0.0		0.00
	Yes	0.0	100.0		
Do you think fortified rice is consumed in developed countries?	No	32.5	14.7	14.29	0.00
	Yes	67.5	85.3		
Did you know that the government has started supplying fortified rice?	No	35.6	9.2		0.00
	Yes	64.4	90.8		
Aware of Government schemes on Rice Fortification	No	0.0	0.0	-	
	Yes	100.0	100.0		
What is fortified rice?	Normal Rice	17.2	2.5	110.18	0.00
	Plastic Rice	19.1	.6		
	Contaminated rice	21.0	0.0		
	Nutritious rice	42.7	96.8		
Who can eat fortified rice?	Pregnant lady	23.3	.6	78.14	0.00
	Children	27.0	6.1		
	Adolescent	0.0	0.0		
	Men	0.0	0.0		
	Women	0.0	0.0		
	Old people	0.0	0.0		
	All Members of the family	49.7	93.3		
Which deficiency causes anemia?	Calcium	32.5	.6	93.42	0.00
	Sodium	1.2	.6		
	Potassium	0.0	0.0		
	Iron	49.1	96.3		
	All above	17.2	2.5		

Prior to the training, only 2.5% of respondents accurately identified the micronutrients in fortified rice. However, the post-test results revealed a

significant increase in this understanding, with 12% ( $P < 0.001$ ) of participants correctly identifying the nutrients. Further, the data indicated that 79%

of participants recognized the purpose of fortifying rice to enhance its nutritive value. Following the training, this understanding improved significantly, with 98% ( $P < 0.001$ ) of respondents acknowledging the role of fortified rice in improving nutritional content.

Furthermore, the post-test results demonstrated a notable shift in participants' perceptions regarding the benefits of consuming fortified rice. While 77% of respondents in the pre-test acknowledged its role in preventing anemia, this figure increased to 95% ( $P < 0.001$ ) in the post-test, indicating a heightened awareness of the health benefits associated with fortified rice consumption. Additionally, there was a considerable increase in the percentage of participants recognizing the impact of fortified rice on overall health, with 71% responding affirmatively in the pre-test compared to a significant increase to 97% ( $P < 0.001$ ) in the post-test. The post-test outcomes also highlighted a significant improvement in participants' ability to identify fortification logo, with 95% correctly recognizing the (+F) post-intervention, compared to only 60% in the pre-test. Further the findings suggest that a substantial increase in awareness of government initiatives related to rice fortification, with 91% ( $P < 0.001$ ) of participants indicating awareness post-intervention compared to 64% in the pre-test.

#### ***Behavior and use of Fortified Rice among the service providers***

Understanding the behavior and use of fortified rice (FR) among service providers is crucial for assessing the effectiveness of nutritional interventions and promoting the adoption of FR within communities. Service providers play a pivotal role in disseminating information,

distributing fortified rice, and influencing consumer choices regarding dietary practices. Their behavior and utilization patterns can offer insights into the acceptance, accessibility, and integration of FR into existing food systems. Factors such as knowledge of FR's nutritional benefits, perceptions of taste and sensory attributes, logistical considerations in procurement and distribution, as well as communication strategies employed by service providers, all contribute to shaping the utilization of FR. Table 4 provides details about current practices of FR among the service providers.

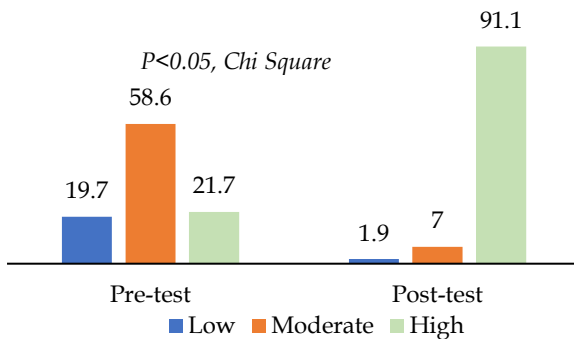
The comparison between pre-test and post-test results regarding the consumption and preference for fortified rice reveals notable shifts in participant behavior and attitudes. Initially, in the pre-test, 88% of respondents indicated they did not consume fortified rice, while only 12% reported consuming it. However, after the intervention, there was a significant increase in the proportion of participants who consumed fortified rice, with the percentage rising to 44% ( $P < 0.001$ ). Similarly, regarding the preference for cooking fortified rice for their families, there was a substantial change in attitudes post-intervention. Prior to the intervention, 44% of respondents expressed a reluctance to cook fortified rice, whereas post-intervention, this percentage dramatically decreased to 7% ( $P < 0.001$ ). These findings suggest that the intervention effectively influenced participants' behaviors and preferences towards the consumption and preparation of fortified rice, indicating a positive impact on their acceptance and adoption of fortified rice for nutritional benefits.

**Table 4** Behavior and use of Fortified Rice

Indicators	Response category	Round of Interviews		Pearson Chi Square	Sig. (P Value)
		Pre-test	Post-test		
Did you eat fortified rice?	No	87.7	56.4	39.65	0.00
	Yes	12.3	43.6		
Would you prefer to cook fortified rice for your family?	No	43.6	7.4	56.26	0.00
	Yes	56.4	92.6		

### The KAP Index

The KAP index presents the change in training outcomes during the pre-test and post-test interviews. The mean score of KAP index during the pre-test was 13 (SD 3.23) which increased to 19.6 (SD 3.01) at the post-test. In another analysis, the KAP index showed a significant positive shift in KAP Score. During the pre-test phase, nearly one-fifth (19.7%) of the service providers exhibited a low KAP outcome. However, after the training program, this proportion significantly dropped to 2% during the post-test assessment. Similarly, while a significant majority (58.6%) of participants initially demonstrated moderate KAP outcomes in the pre-test, this figure dropped to just 7% in the post-test. The most notable change was observed in the high KAP outcome category, during the pre-test the KAP score under the high category was only 22% which rose significantly to 91% in the post-test.



**Figure 3** Change in KAP index

This progression underscores the impact of the training, resulting in enhancement in participants' knowledge acquisition, attitude refinement, and practical application of the training material. Consequently, the combined data across both interview rounds outline a convincing narrative, with a majority (56.4%) of participants achieving a commendable high KAP outcome.

### Summary and Conclusions

The study investigated the impact of an intervention on participants' perceptions, understanding, and behavior regarding fortified rice. Initially, a significant majority favored normal

rice over fortified rice, but post-training, there was a considerable increase in preference for fortified rice, indicating improved perception of its sensory qualities and nutritional value. Moreover, participants' support for distribution of fortified rice increased after the intervention. There was also a notable rise in participants' interest in learning more about fortified rice. There is a need for context-specific and evidence-based measures to combat malnutrition and promote healthy nutrition, offering insightful information for decision-makers in healthcare and policy (Rufati & Awalia, 2023).

Further analysis revealed significant improvements in participants' understanding of fortified rice's nutritional benefits and its role in preventing anemia and promoting overall health. Additionally, there was an increase in the ability to recognize fortification logo and awareness of government initiatives related to rice fortification.

Regarding behavior and use among service providers, there was a notable increase in the proportion of participants consuming fortified rice post-intervention, along with a positive shift in attitudes towards its preparation and consumption for their families. The study also introduced a Knowledge, Attitude, and Practice (KAP) Index, demonstrating a substantial enhancement in participants' knowledge acquisition, attitude refinement, and practical application of the training material. The findings highlight the effectiveness of the intervention in improving perceptions, understanding, and behavior related to fortified rice among participants. The significant shifts observed in preferences, attitudes towards government policies, and consumption patterns underscore the positive impact of targeted interventions in promoting the adoption of fortified rice for its nutritional benefits. The findings corroborate with similar training of service providers and their improved service delivery after the training (Rowe et al., 2021) (Geibel et al., 2017). Ideal health communication can benefit and influence the adoption of a nutrition intervention for informed choice by the user.

Moreover, the substantial increase in the KAP Index scores reflects a comprehensive improvement in participants' knowledge, attitudes, and practices, indicating the success of the training program. These results emphasize the importance of continued efforts to enhance awareness and acceptance of fortified rice. This study further brings to light the fact that despite a constrained understanding of both the sensory and physiological properties of fortified rice, service providers exhibit positive perspectives regarding its supply as a government-supported nutrition program for the prevention of anemia. Recognizing the existing gap in awareness, this study serves as a vital need-gap assessment, offering insights that can inform the development of strategies aimed at capacity building. These strategies may encompass the formulation of training syllabi, modules, instructional methods, and other educational materials tailored to the specific needs of the trainees. To enhance comprehension and engagement, a recommended approach involves sensitization efforts, facilitating direct interaction between the service providers and both respondents and experts knowledgeable in fortified rice. It is emphasized that service providers equipped with enhanced awareness and clear perceptions regarding fortified rice are crucial elements for ensuring the successful and seamless implementation of the program.

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