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Sensory and consumer evaluation of iron fortified rice

Supta Sarkar[1], Aparna Kuna[1], MM Azam*[2], M Sowmya[1], E Suneel Kumar[1]

[1]Post Graduate & Research Centre, Professor Jayashankar Telangana State Agricultural University, Hyderabad

[2]Indian Institute of Rice Research, Rajendranagar, Hyderabad

Email : mohibbe.azam@gmail.com

ABSTRACT

Rice being a staple food has the potential to be a good vehicle for fortification and as such can be a valuable vehicle for alleviating micronutrient deficiencies. However, for rice to be an effective delivery vehicle for iron, its sensory parameters should be similar to that of good quality non-iron fortified rice. In the present study, sensory properties were studied for six locally consumed rice products prepared with both iron fortified (35ppm $Na_2FeEDTA$) and non-iron fortified rice. The best acceptable product according to statistical analysis was selected for consumer evaluation by a total of 100 randomly chosen respondents. There was no significant difference in overall acceptability between the normal and fortified rice and thus the iron fortified rice product was well accepted by the respondents.

Key words: *Rice, fortification, iron fortified rice, sensory evaluation, consumer evaluation*

Iron deficiency anemia (IDA) remains as a serious public health problem across population groups, as at any given moment globally more individuals have IDA than any other health problem affecting 24.8% of the total population (WHO, 2005). Physical and cognitive losses due to IDA cost developing countries up to 4.05% loss in gross domestic product (GDP) per annum, thereby stalling social and economic development. When results are expressed as a percentage of GDP these losses are 1.18% of GDP in India (Horton and Ross, 2003). Clearly, the burden is large and the consequences are serious. According to a panel of Nobel laureates, of the top 10 priorities selected for advancing global welfare, 5 were in the area of nutrition-micronutrient supplements, micronutrient fortification, biofortification, de-worming and other nutrient programmes at school and community level (Copenhagen Consensus, 2008). The magnitude of anemia together with the associated adverse health, development and economic consequences, highlights the need for intensified action to address this public health problem (Ezzati *et al*., 2002 and Ezzati *et al*., 2004). In general, three nutritional intervention strategies are currently in use to combat micronutrient malnutrition: 1) increasing the dietary intake of foods rich in micronutrients by dietary diversification, 2) periodic supplementation with target micronutrients and 3) fortification with one or more micronutrients of commonly consumed dietary items (Hurrell, 2002). While dietary modification and supplementation have offered some improvement in developing countries, economic constraints and low rates of compliance are major concerns associated with these strategies. Fortification appears to be the best long-term nutrition intervention strategy for controlling most Micronutrient Deficiencies (MND) (De Romana *et al*., 2002).

Food fortification has become an important contributor to innovative products in several markets. Evidence supports that food fortification is the most cost effective long term approach to reduce nutrient deficiency in populations (Baltussen *et al*., 2004; Laxminarayan *et al*., 2006). Fortification of staple foods has been shown to effectively reduce the burden of vitamin and mineral deficiencies in vulnerable populations (FAOSTAT, 2014). Fortifying staple foods

offers a great opportunity to control MND.

Rice is the agricultural commodity with the third-highest worldwide production (FAOSTAT, 2012). It is a staple food consumed by more than half of the world's population (FAOSTAT, 2014), which provides 20% of the world's dietary energy supply, while wheat supplies 19% and maize (corn) 5% (FAO, 2004). Rice is the predominant dietary energy source for 17 countries in Asia and the Pacific, 9 countries in North and South America and 8 countries in Africa. In 59 countries, an average of at least 75 grams of rice is available per person per day (FAOSTAT, 2014). This suggests that in areas where rice is a staple food, it has the potential to be a good vehicle for fortification as even small increases in nutrient levels could have a positive health impact (FFI, 2014).

However, for rice to be an effective delivery vehicle for iron, its color, flavor and price should be similar to that of good quality non-iron fortified rice. It has to be white in color, with the flavor of good quality rice and at a price similar to the latter. These characteristics are not easy to achieve in iron fortified rice due to the effect of adding iron on the color of the cooked rice, and on the price of the iron fortified rice. Both color and price are factors that affect the purchase of rice of low income consumers. It is thus necessary to determine the acceptance of iron fortified rice to consumers (San Juan *et al*., 2011). Hence an effort has been made to fortify a normally consumed *Sampada* variety rice with 35ppm of $Na_2FeEDTA$ which was then subjected to sensory evaluation by semi-trained panel members and consumer acceptability was assessed by randomly selected respondents. The main objective of the study was to assess the sensory properties and consumer acceptability of the iron fortified rice.

Sensory evaluation was conducted in a purpose-built, ten-booth sensory evaluation laboratory. Six standardized products–plain rice, carrot rice, vegetable biryani, pudina rice, kheer and pulihora which are consumed locally were prepared with both normal rice (control) and iron-fortified rice (experimental) and were subjected to sensory evaluation by 15 semi-trained panel members (consisted of staff and graduate students of the Department of Foods and Nutrition) by using a sensory evaluation score card at the Department of Foods and Nutrition, Post Graduate and Research Centre (PGRC), Professor Jayashankar Telangana State Agricultural University (PJTSAU), Hyderabad. Each day two rice product samples (control & experimental) were served which were coded by using random three-digit numbers. Panelists were provided with water and instructed to rinse and swallow water between samples. For sensory testing, cooked rice samples were freshly prepared and kept in a heated box (60±5°C) until ready for serving. The rice samples served to the panel members were close to ambient temperature which varied between 25 and 30°C. A 7-point hedonic scale (7 = Like very much, 6 = Like a lot, 5 = Like, 4 = Neither like nor dislike, 3 = Dislike, 2 = Dislike a lot,1=Dislike very much) was used to determine the acceptance rating for sensory parameters - appearance, color, odour, tenderness, taste and overall acceptability (Meilgaard *et al*., 1999).

Statistical analysis (student's t-test and analysis of variance) showed vegetable biryani (6.26±0.70) scored highest in overall acceptability which was subsequently selected for the consumer acceptability evaluation. A total of 100 subjects were selected randomly for the consumer evaluation which was conducted at the Department of Foods and Nutrition, PGRC, PJTSAU, Hyderabad, Indian Institute of Rice Research (Formerly Directorate of Rice Research), Rajendranagar, Hyderabad and College of Home Science, Saifabad, Hyderabad by using a consumer acceptability questionnaire consisting of two sections describing the demographic profile of the respondents and the hedonic scoring for the vegetable biryani (control & experimental) coded with random three-digit numbers. Cooked rice samples of vegetable biryani were freshly prepared and kept in a heated box (60±5°C) until ready for serving. The rice samples served to the consumers were close to ambient temperature which varied between 25 and 30°C. A 5-point hedonic scale (5=Like very much to 1=Dislike very much) was used to determine the consumer acceptance rating for sensory parameters - color, odour, taste and overall acceptability (Meilgaard *et al*., 1999).

The results of sensory evaluation of six developed products prepared with normal rice (N) and iron-fortified rice (I) of *Sampada* variety (Table 1) are summarized in the Table 2.

Results indicated that there was no significant difference in appearance, odour and tenderness on

Table 1. Type of products prepared using normal and iron fortified rice

Product Name	Type of rice used	Code	Type of rice used	Code
Plain Rice (PR)	Normal Rice (N)	PRN	Iron fortified Rice (I)	PRI
Carrot Rice (CR)	Normal Rice (N)	CRN	Iron fortified Rice (I)	CRI
Vegetable Biryani (VB)	Normal Rice (N)	VBN	Iron fortified Rice (I)	VBI
Pudina Rice (PD)	Normal Rice (N)	PDN	Iron fortified Rice (I)	PDI
Kheer (KR)	Normal Rice (N)	KRN	Iron fortified Rice (I)	KRI
Pulihora (PH)	Normal Rice (N)	PHN	Iron fortified Rice (I)	PHI

Table 2. Mean scores of sensory evaluation of six different rice products of normal rice (sampada) and iron fortified rice

Sensory Parameters	Variety	Plain rice (PR)	Carrot rice (CR)	Vegetable biryani (VB)	Pudina rice(PD)	Kheer(KR)	Pulihora(PH)	S.E value	F value
Appearance	N	5.73±0.7	5.60±0.90	6.00±0.75	5.53±0.51	5.80±0.56	5.93±0.70	0.14	1.51NS
	I	5.40±1.24	6.06±0.70	6.06±0.96	5.66±0.48	5.46±0.74	5.60±0.98		
S.E value				0.08					
F value				0.31NS					
Colour	N	5.73±0.88	5.66±0.72	6.06±0.70	5.46±0.74	5.93±0.70	6.26±0.59	0.14	2.79*
	I	5.33±1.11	5.73±0.70	6.06±0.59	5.60±0.73	5.26±0.70	5.73±0.96		
S.E value				0.08					
F value				4.06*					
Odour	N	5.13±0.99	5.66±0.90	5.26±1.22	5.46±1.06	5.86±0.83	5.66±1.04	0.17	1.38NS
	I	5.40±0.91	5.26±0.96	5.46±1.12	5.20±1.01	5.46±0.51	5.93±0.88		
S.E value				0.10					
F value				0.15NS					
Tenderness	N	5.33±0.97	5.46±0.91	5.73±0.96	5.46±0.91	5.46±0.83	5.73±0.96	0.16	1.84NS
	I	5.20±0.94	5.33±0.81	6.00±0.75	5.53±0.83	5.46±1.06	5.73±0.70		
S.E value				0.09					
F value				0.01NS					
Taste	N	5.13±1.12	5.66±0.90	5.73±1.03	5.86±0.74	6.26±0.79	6.26±0.79	0.16	3.16**
	I	5.53±0.91	5.80±1.01	6.13±0.83	5.33±0.90	5.60±0.73	6.06±0.96		
S.E value				0.09					
F value				0.33NS					
Overall acceptability	N	5.53±0.83	5.73±0.79	5.86±0.91	5.73±0.70	6.06±0.79	6.46±0.74	0.14	3.75**
	I	5.40±0.91	5.73±0.70	6.26±0.70	5.46±0.91	5.53±0.64	5.93±0.70		
S.E value				0.08					
F value				2.30NS					

Note: Values are expressed as mean±SD, NS- Not significant, *-significant at 5% level, **- significant at 1% level
N – Normal Rice; I – Iron Fortified Rice.

comparing the two different rice varieties (N and I) as well as within the six different rice products - PR, CR, VB, PD, KR and PH. A significant ($p<0.05$) difference existed between the colour of different products prepared with normal and iron fortified rice. There was also a significant ($p<0.05$) difference among the colour of the six different rice products when compared to each other indicating a non-uniformity in colour within the products. Colour scores were higher for products prepared with normal rice (PH- 6.26±0.59), than iron fortified rice. The results of taste indicated that there was no significant difference ($p<0.05$) between the taste of different products prepared with normal and iron fortified rice, however, taste varied significantly ($p<0.01$) within the products of normal and iron fortified rice. There was no significant difference in overall acceptability between the six products of normal and iron fortified rice. However a significant ($p<0.01$) difference existed within the products of normal and iron fortified rice. The results of overall acceptability comparison among the products prepared with normal rice indicated that PHN (6.46±0.74) was the highest acceptable and VBI (6.26±0.70) was the highest acceptable product prepared with iron fortified rice.

Hence VBI (6.26±0.70) was selected to carry out the consumer acceptability study. The iron content affected (Pd"0.05) sensory acceptability of colour, flavor, elasticity, smoothness, firmness and acceptability (Reungmaneepaitoon and Sikkhamondhol, 2008). The iron content showed significant effects on color and acceptability in a study of rice pasta by Reungmaneepaitoon and Sikkhamondhol, 2008. The sensory scores in terms of color and acceptability of the rice pasta fortified with 30% iron of RDI were higher than those fortified with 60% iron of RDI (Required dietary intake). Our study results were similar to the findings of Nabeshima *et al*. (2005) and Radhika *et al.* (2011) where the results indicated that the difference in scores of overall acceptability was not statistically significant, suggesting that both types of rice were well accepted with no significant detectable differences between the fortified samples and the standard ones.

Table 3. Demographic profile of respondents participated in consumer evaluation

1.Age (n=100)	
i. 18-29 years	91%
ii. 30-39 years	3%
iii. 40-49 years	3%
iv.50-60 years	3%
2.Sex (n=100)	
i. Male	18%
ii. Female	82%
3. Education (n=100)	
i. Primary	0
ii. Secondary	0
iii. Higher Secondary	54 %
iv.UG	6%
v. PG	32%
vi. Doctorate	7%
vii. Other	1%
4.Frequency of consuming rice (n=100)	
i. Daily	100%
ii. Thrice a week	0
iii. Twice a week	0
iv.Once a week	0
v. Rarely	0
vi. Never	0
5.Amount of rice consumption per day (No. of cups) (n=100)	
i. Breakfast	0.54±0.51
ii. Lunch	1.93±0.40
iii. Dinner	1.60±0.47
6. Awareness of iron fortified rice (n=100)	
i. Yes	93%
ii. No	7%
7. Tasted iron fortified rice any time before	
i. Yes	16%
ii. No	84%
8. Awareness of health benefits of iron fortified rice (n=100)	
i. Yes	80%
ii. No	20%
9. Willingness to buy (n=100)	
i. Yes	94%
ii. No	6%
10. Price willing to pay (n=100)	
i. Rs.30 or less	24.46%
ii. Rs.31 – 40	46.80%
iii. Rs.41 – 50	28.72%
iv. Rs.51 or above	0

A total of 100 subjects, including 18 males and 82 females were randomly selected for the consumer acceptability study from the age group of 18-60 years based on their interest in participating in the study. The results of consumer acceptability are summarized in Table 3. The study was done by using a consumer acceptability questionnaire consisting of two sections describing the demographic profile and the hedonic scoring for the vegetable biryani.

The results of demographic profile of the respondents of consumer evaluation study revealed that 100% of the respondents consume rice daily, 93% were aware about iron fortified rice, whereas 80% were aware about health benefits of iron fortified rice. Results from the study indicated that 94% of the respondents were willing to buy iron fortified rice whereas 6% were not willing to buy. The high percentage of awareness about iron fortified rice and the health benefits of iron fortified rice could be the reason for higher frequency of willingness to buy iron fortified rice. There are studies which suggest that acceptability for products is related to consumer attitude and knowledge about the health claims of the product (Drake and Gerard, 2003; Ramcharitar *et al.*, 2005). The level of acceptance slightly increases as the demographic profiles elevate from one rank to another (San Juan *et al*., 2011). In terms of price willing to be paid by the respondents it was found that 28.72% were willing to pay Rs.41 or above per kg of rice, whereas, the market information on the price for premium quality of normal rice ranges between Rs.40-50 or above for per kg of rice. The result of a study by Vasudevan *et al.* (2013) showed consumers' interest and willingness to substitute brown rice for white rice provided it was available at an affordable price and information about the health benefits were provided.

The results of hedonic scoring for vegetable

Table 4. Hedonic scoring by respondents for consumer evaluation

Samples	COLOUR (n=100)	ODOUR (n=100)	TASTE (n=100)	OVERALL ACCEPTABILITY (n=100)
Vegetable biryani - Normal rice(VBN)	4.26±0.63	3.99±0.68	4.26±0.63	4.26±0.48
Vegetable biryani -Fortified rice(VBI)	4.19±0.73	4.01±0.77	4.19±0.73	4.25±0.65
SE value	0.05	0.05	0.09	0.06
F value	0.83^{NS}	0.07^{NS}	0.56^{NS}	0.01^{NS}

Note: Values are expressed in Mean±SD. ^{NS} indicates Non Significant difference.

biryani provided for consumer evaluation study is summarized in Table 4. The results indicated that no significant differences were found between the hedonic ratings of the sensory attributes of normal and iron fortified rice product. The results of consumer acceptance study showed that according to analysis of variance there was no significant difference in the sensory attributes of the product prepared with normal rice and iron fortified rice. The iron fortified rice product was well accepted by the respondents (n=100) selected for consumer acceptability study.

The sensory properties of the iron fortified rice products did not vary significantly when compared to normal rice products. Hence it can be concluded that the rice fortified with 35ppm $Na_2FeEDTA$ can be an effective solution to prevent the enormous prevalence of anemia.

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