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Consumer Acceptance and Preference Study [CAPS] on Brown and Under Milled Indian Rice Varieties in Chennai, India

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Abstract

Objectives—To study consumer acceptance of unmilled brown and under milled rice among urban south Indians.

Methods—Overweight and normal weight adults living in slum and non-slum residences in Chennai participated (n=82). Bapatla (BPT) and Uma (red pigmented) rice varieties were chosen. These rice varieties were dehusked (unmilled, 0% polish) and further milled to 2.3% and 4.4% polishing (under milled). Thus nine rice samples in both raw and parboiled forms were provided for consumer tasting over a period of three days. A hedonic 7-point scale was used to rate the consumer preferences. A validated questionnaire was used to collect demographic, anthropometric, medical history, physical activity, dietary intake data and willingness of the consumers to switch over to brown rice.

Results—Consumers reported that the color, appearance, texture, taste and overall quality of the 4.4% polished rice was strongly preferred in both varieties and forms. Ratings for 0% polished (brown rice) were substantially lower than those of 2.3% polished rice, which were intermediate in ratings between 0% and 4.4% polishing. However, most of the consumers (93%) expressed willingness to substitute brown or 2.3% polished rice if affordable after the taste tests and education on nutritional and health benefits of whole grains.

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Declaration of interest

V.M., V.S., W.W. and D.S. designed the study. V.S. led the data collection along with M.M.P. and K.A., was involved in the methodology. V.S. wrote the first draft of the manuscript. B.H., D.S analyzed the data and wrote the statistical analysis and results section. F. H., V.M., N.M.W., V.S., Va. M., C. J. and M.R.B reviewed the manuscript and contributed to the interpretation of data. All authors contributed to the revision and finalization of the manuscript. All authors declared that they have no duality of interest associated with this manuscript.

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Conclusion—While most consumers' preferred polished white rice, education regarding health benefits may help this population switch to brown or under milled rice. Cooking quality and appearance of the grains were perceived as the most important factors to consider when purchasing rice among Chennai urban adults.

Keywords

white rice; red rice; raw rice; parboiled rice; diabetes; obese Asian Indians

INTRODUCTION

Currently it is estimated that India has over 61.3 million people with diabetes and this number is projected to rise to 101.2 million by the year 2030 [1]. A recent study from our centre found at least 62.4 million people with diabetes and another 77.2 million with pre diabetes in India [2]. The term 'Asian Indian Phenotype' [3, 4] describes the increased insulin resistance (IR) in Asian Indians due to which diabetes and coronary artery disease occur a decade earlier in Indians compared to people of European ancestry. In 2005, 53% of all deaths and 44% of Disability Adjusted Life Years (DALY's) lost were attributed to chronic diseases (including diabetes, coronary artery disease and cancer) [5]. The prevalence of type 2 diabetes parallels the increase in obesity rates among Indians, which is attributed to increasingly sedentary lifestyle and consumption of foods high in calories, fat and particularly refined carbohydrates [6, 7].

Cereals continue to be the main staple food among south Indian adults, providing at least half of the total calories consumed [8, 9]. Today such a cereal staple diet is mainly derived by refined cereals such as white rice, which also contributes to high glycemic load (GL). Higher dietary GL has been found to be positively associated with type 2 diabetes risk [10]. In the traditional south Indian diet, carbohydrates were typically derived from 'under milled' grains such as hand pounded rice [11]. Today, hand pounded rice has been replaced by polished 'white rice' (refined grain, 8% polish) due to modern milling technology to increase rice yield [12]; the degree of whiteness of rice is a surrogate for the degree of polishing of rice.

Habitual consumption of refined grains has been associated with a higher risk of type 2 diabetes mellitus and metabolic syndrome among urban adult Indians, Chinese and Caucasians [9, 13, 14]. Several studies have documented the beneficial effects of consuming whole grains (such as brown rice) to reduce postprandial blood glucose levels [15] and improve lipid profiles [16]. In addition, whole grain products contain additional beneficial nutrients, including more fibre, micronutrients and phytonutrients [11]. In India, lack of awareness about whole grains may be due to the virtual disappearance of whole grain products from the market [17].

The present study was conducted to evaluate consumer awareness about the nutritional properties of, and preferences for whole grains, particularly 'brown' rice (0% polished) and 'under milled' rice (2.3% and 4.4% polished) in an urban south Indian population. The study also aimed to explore the feasibility of introducing brown rice as a staple for several months in the south Indian diet substituting for fully polished rice. There is a limited awareness among the people about the health benefits of whole grains such as brown rice [18]. To our knowledge, this is the first study of this nature from India.

MATERIALS AND METHODS

Participants

The Consumer Acceptability and Preference Study (CAPS) was conducted among adult habitual rice consumers from selected non-slum and slum areas of Chennai city (formerly Madras) in southern India. This sampling strategy was designed to obtain data across different socio-economic groups [19]. Overweight, obese (Asia specific body mass index [BMI] cutpoint for overweight ≥23 kg/m^2 and obesity ≥25 kg/m^2) and normal weight (BMI ≥18.5–22.9 kg/m^2 [20] adults living in selected slum (Santhosh Nagar in Egmore and Moolakothalam in Mint) and non-slum (Parson Nagar, Saidapet, Chennai city) residences were recruited.

The research team initially established contact with a few key persons in these residential areas to recruit volunteers to participate after explaining the purpose of the study. A total of 82 consumers were recruited, which included 38 men and 44 women. Equal representation of slum and non-slum groups as well as overweight, obese and normal weight participants was ensured. Participants with known diabetes or any other chronic diseases were excluded from this study as they may be on specific therapeutic diets. The protocol for the study was approved by the IRB (Institutional Review Board) of the Harvard School of Public Health and the Institutional Ethics Committee of the Madras Diabetes Research Foundation and written informed consent was obtained from all study participants.

Rice Samples and Cooking Methods

Two varieties of rice commonly consumed in south India were chosen, namely the Bapatla (BPT) variety (both raw and parboiled forms) and Uma red rice variety (parboiled form). Currently, the type of rice that is available in the market is polished white rice (8% polished); unpolished (unmilled) rice is not readily available. Therefore, a paddy variety of BPT (both raw and parboiled forms) and parboiled paddy of Uma red rice were dehusked in rubber roll shellers separately to get brown rice (unmilled, 0% polish), and further subjected to different degrees of polishing. This was a manually controlled process performed at the rice mill to obtain the desired degree of polishing and estimated as [1− (weight of milled rice / weight of brown rice) × 100] [21]. Under milled rice (2.3% and 4.4% polished) was obtained using horizontal polishers. This resulted in an overall total of nine rice samples (BPT Raw rice: 0%, 2.3% and 4.4% polished; BPT Parboiled rice: 0%, 2.3% and 4.4% polished and Parboiled Uma red rice: 0%, 2.3% and 4.4% polished) for the purpose of consumer tasting and evaluation. All of the rice samples were served with '*sambar'*, a popular south Indian food choice. '*Sambar'* is a gravy dish made from lentils and vegetables cooked in a spicy tamarind sauce. All rice samples were cooked in a pressure cooker, the most common household method for cooking rice, and the ratio of rice: water (by volume) was 1:2 for brown rice (0% polished) and 1:2.8 for under milled (both 2.3% and 4.4% polished) rice samples.

Procedure

A validated questionnaire (i.e., CAPS questionnaire) was used for this study and interviewer-administered to collect demographic, anthropometric (using standardized methods [22]), medical history, physical activity and dietary intake data with emphasis on the rice consumption habits of consumers prior to tasting. Inter-rater reliability to measure the degree of agreement between the interviewers was assessed. One interviewer administered the CAPS questionnaire to the participant while all others observed and independently rated the participant's response passively on their respective questionnaires. This process was completed for a total of 10 consumers by all 7 interviewers, all of whom were trained research dietitians. The average intra-class correlation (ICC) with Spearman

Brown correction was 0.8, indicating good agreement among the interviewers. To assess *test-retest reliability*, the CAPS questionnaire was first administered to 50 consumers and then re-administered to the same consumers after a time-span of 7–10 days. The correlation between the measures taken at the two separate time points determined using the κ-statistic was 0.97, indicating excellent reliability.

Face and content validity were also assessed. To assess *face validity*, experts in the field (i.e., sensory scientists, food technologists, nutritionists) carefully reviewed the CAPS questionnaire and provided input as to its relevance, applicability and comprehensiveness in the Indian context. These suggestions were discussed with the study team and incorporated into the questionnaire accordingly. To determine *content validity*, interviews had been conducted with potential consumers to help derive the items and assess the adequacy and relevance of the items to the Indian cultural context.

Consumers were invited to taste all of the rice dishes, sensory attributes were ascertained and a post-tasting questionnaire was further administered to evaluate the acceptability and willingness of consumers to substitute brown rice for white rice to lower diabetes risk. Dietary intake was also assessed using a validated food frequency questionnaire (FFQ) [23]. In the CAPS questionnaire, the interviewer administered and recorded the sensory attributes before and after tasting of 0%, 2.3% and 4.4 % (raw and parboiled forms) and *uma* red rice as uncooked rice, plain cooked rice and cooked rice with *sambar* for color, appearance, taste, texture and overall quality. In addition, their willingness to substitute, buy (yes / no/ do not know) either the under milled rice or the unmilled rice (0% polish) after tasting the cooked rice (both in the plain form as well as with the *sambar)* was also recorded. Research dietitians explained one- on- one about the health benefits of the under milled rice and unmilled rice.

The tasting was conducted in the presence of an interviewer over a period of 3 days with one day being allocated for one variety and one form of rice (BPT Raw/ BPT Parboiled/ red Parboiled) to avoid mental fatigue and confusion. Thus, each participant was served a maximum of three samples of rice with '*sambar'* per day (e.g., Raw rice 0%, 2.3% and 4.4% polish). Consumers were asked to rate and report the '*overall quality'* and preference for the '*color', 'appearance', 'taste'* and *'texture'* of the uncooked and cooked rice samples on a 7-point Hedonic scale, with "1" representing 'Like very much' and "7" 'Dislike very much' [24].

Statistical Methods

Standard descriptive statistics were used to summarize the basic characteristics of the study participants (Tables 1, 2 and 4). In Table 3a and 3b, the significance of any differences observed in sensory attributes across the rice varieties, forms and presentations (different degrees of polishing) were assessed using the non-parametric Kruskal-Wallis test. We also investigated the determinants of willingness to consider a switch from white to brown rice for a period of several months. First, stepwise logistic regressions were run for each potential predictor among the groups of variables in each of the following categories: socio-demographic characteristics, health characteristics including anthropometrics, physical activity attributes, dietary intake and sensory attributes. Next, a stepwise logistic regression model was run including the variables that were significant in the first set of logistic regression models. The missing indicator method was used to handle the small amount of missing data [25].

RESULTS

Table 1 provides the characteristics of the study population. Thirty-eight men and forty-four women completed this study and the majorities were Hindu and spoke Tamil. Most of the study participants were married and literate, although 30% of the women had only a primary school education. Nearly half of the participants had completed an undergraduate or graduate college degree (data not shown). Two thirds of the men and half of the women reported sedentary work.

By design, half of the participants lived in slums and the other half in non-slum residences. Again by design, half were overweight or obese and half had a normal BMI. None of the women were smokers or reported consumption of alcoholic beverages, while 60% of the men were non-smokers and the same proportion reported current consumption of alcoholic beverages. Having a family history of diabetes was reported to be high (men 47.4%; women 34.1%), as was family history of cardiovascular disease (men 28.9%; women 31.8%) and obesity (men 42.1%; women 38.6%).

In this study, carbohydrates contributed 60% of total calories. All of the participants in this study consumed rice and rice based dishes daily in all 3 meals, either as '*tiffin'* (a colloquial English term for a light meal [26]) items such as *dosa,* or *idly* (pancake and steamed rice cake made out of fermented batter with polished parboiled rice as the main ingredient) for breakfast and dinner and plain cooked rice for lunch. Almost all of the participants consumed polished rice as their staple food possibly contributing to a high dietary glycemic index (GI) and GL. (Table 2).

Tables 3a and 3b provide the sensory attributes after tasting the 9 rice samples. Color, appearance, texture, taste and overall quality of the 4.4% polished rice was strongly preferred among all varieties of rice. Consumers were able to distinguish between raw and parboiled rice in nearly all of the features assessed. Ratings for 0% polished rice were substantially lower than those of the 2.3% polished rice, which were intermediate in ratings between 0% polished and 4.4% polished. Uma red rice received lower ratings than the BPT rice variety.

Participant willingness to substitute their usual rice choice for brown rice or 2.3% polished rice after the taste tests and brief education on the nutritional and health benefits of whole grains is presented in Table 4. Ninety-two percent of the consumers expressed their willingness to substitute brown (unmilled) or under milled rice, if affordable, for white rice. Sixty-one percent expressed their interest to switch to brown rice every day for several months (6 months) and 26% were uncertain whether or not they would be able to switch.

Eighty-seven percent of the men expressed willingness to switch to brown rice daily, while only 38% of the women expressed willingness (p=0.004). Similarly, 82% of those who did not buy the rice for their family expressed their willingness to change to brown rice, while 43% of those who bought the family's rice indicated willingness to change (p=0.006). In the focus group discussions reported elsewhere [19], it became evident that young people in the family were the most difficult group to change, and participants did not believe that their families would eat the less polished rice.

Those who disliked the 0% polished raw rice were significantly less likely to be willing to change for several months (p=0.001). No other characteristic reported in Tables 1 and 4 were significant independent determinants of willingness to change to brown rice including slum dwelling, BMI, education and income.

DISCUSSION

The CAPS study was conducted to ascertain awareness of the nutritional properties and preferences for whole grains, particularly brown rice and under milled rice, among slum and non-slum adult consumers in Chennai, a large city in southern India. The most important finding was that most men and about half of the women were willing to switch over to brown rice /under milled rice (2.3% polish) for several months as a staple cereal, and they reported liking the under milled rice better than the brown rice (0% polish). The majority of participants preferred parboiled rice and expressed cooking quality and the appearance of 'uncooked' grains as the most important factors to consider when purchasing rice. These reasons were consistently reported in the focus group discussions conducted among these participants [19].

India is the world's second largest producer of rice, accounting for 80% of the World's rice eating population. The production of rice in India has shown an increasing trend from 91.1 million tonnes in 2009 to 99.1 million tonnes during 2010 [27]. White rice is a major contributor of total refined grain intake, which provides almost half of the daily calories in the region [9]. There has been a shift from the consumption of coarse grains such as sorghum, barley, rye, maize and millet to the consumption of rice among all income groups in Asian countries like India and China [28].

Several research studies have indicated the relation between high dietary GI and GL and an increased risk for type 2 diabetes mellitus [29, 30]. Moreover, high refined grain intake provides less protein and dietary fibre reflecting overall poor diet quality. [31]. Health education about brown rice to the participants emphasized that brown rice is rich in micronutrients such as magnesium and B vitamins and is considered to have a low GI value with a decreased amount of available carbohydrate and high cereal fibre content, all of which may decrease the risk of type 2 diabetes [32, 33]. Nutrient losses occur proportionately with increases in the degree of polishing. The findings from a study evaluating the nutritional and sensory profiles of Indian rice varieties milled to different degrees of polishing showed that the dietary fibre content of brown rice for both the BPT and Uma red rice varieties decreased significantly when milled to 8% polishing (81, 64 and 58% decrease in dietary fibre content for BPT raw, BPT parboiled and Uma red rice parboiled brown rice samples, respectively), whereas the available carbohydrate content of the samples increased with increases in the degree of polishing [34].

The barriers reported for the acceptance of brown rice were its chewy texture, poor appearance of both cooked and uncooked grains, longer duration of cooking time and lack of familiarity with brown rice as reported in the present study and elsewhere [35]. For years, Indian consumers have preferred white rice to brown rice because of perceptions that it is of better quality, whiter, cleaner and was associated with higher socio-economic status [19]. Elsewhere, studies on consumer preferences of rice have reported preference for parboiled over milled rice and that cooked grains should be firm and non-sticky [36, 37]. Similarly, participants in the present study expressed their preference for parboiled rice. In Sri Lanka, factors influencing preference were percentage of head rice (rice grain without broken pieces), shape of milled rice and aroma [38] and in the Philippines, milled rice that had a soft texture was preferred [39].

Schutz and Damrell (1974) [40] reported a high correlation between Hedonic ratings by US consumers and sensory attributes by a trained panel for brown rice. In our study, despite the barriers mentioned above and considering the potential health benefits of brown rice learnt through health and nutrition education, the majority of participants were willing to switch to brown rice if the cost was affordable.

In the present study, we found that very few people were aware of the nutritional properties of brown rice. A need to aggressively promote brown rice, highlighting its nutritive properties and health benefits, was suggested by all participants in this study. Efforts to improve the taste and texture of brown rice were considered important as reported elsewhere [37]. These key findings suggest that the promotion of brown rice should occur in a step - wise process.

In contrast to the consumer ratings, the sensory evaluation by trained panelists [36] suggests that the overall acceptability for both brown rice and 2.3% polished rice may be due to awareness about the nutritional and health benefits of brown rice as most of the panelists were from the food sciences background. Hence, efforts are needed both at a regional and national level to facilitate and encourage consumers with appropriate nutrition education at the community level to substitute brown rice for white rice, which may have implications for reducing the increasing diabetes epidemic in India. This could improve the quality of the high carbohydrate Indian diet with a simple single change in dietary preference for staple cereal grains and may have immense potential to reduce the risk of diabetes.

The limitations of the study include the relatively small sample size and that the sample does not represent the general Indian population. However, the study included diverse socio-economic groups from low (slum) and middle to upper middle (non-slum), in order to understand how socioeconomic status may impact perceptions about brown rice, and all of these groups rated brown rice similarly in taste tests. We included overweight, obese and normal weight participants and found that the willingness to switch to a brown rice based diet did not differ by BMI, and that family and cultural dietary habits are more important determinants of the choice of staple foods in this region.

CONCLUSION

In conclusion, most of the consumers, from both the slum and the non slum areas of Chennai predominantly preferred the 4.4% polished rice followed by 2.3% and 0%, whether it was raw or parboiled. The reason for this was based on the appearance, taste, color and texture of the rice samples. The consumers indicated 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. Hence, the findings from our study will further contribute to the research on the effects of brown rice, a whole grain, on reducing the metabolic risk factors for diabetes, by informing about the feasibility of possible interventions that are likely to be acceptable. To our knowledge, substitution of refined carbohydrate foods such as white rice with brown rice / under milled rice has not been evaluated in randomized clinical trials in India. Thus, there is an urgent need to conduct dietary interventions of staple whole grains to mitigate the burden of the diabetes epidemic in India through such primary prevention efforts.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

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ABBREVIATIONS

BPT	Bapatla
CAPS	Consumer Acceptability and Preference Study
DALY's	Disability Adjusted Life Years
FFQ	Food Frequency Questionnaire
IR	Insulin Resistance
ICC	Intra-Class Correlation
GI	Glycemic Index
GL	Glycemic load

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Table 1

Characteristics of the study participants

Characteristics	Men (n=38) Mean ± SD/% (N)	Women (n=44) Mean ± SD/% (N)
Age (years)	34.4 ± 7.3	32.7 ± 7.4
Slum participants % (n)	52.6%(20)	47. 7%(21)
Religion- Hindu % (n)	94.7% (36)	93.2% (41)
Mother tongue- Tamil % (n)	100% (38)	95.5% (42)
Literate % (n)	92.2 %(35)	93.1% (41)
Married % (n)	68.4% (26)	88.6% (39)
No. of adults in the household	4 ± 1.5	3 ± 1.2
Waist circumference (cm) *	85.6 ± 10.6	82.5 ± 10.1
Physical activity-Sedentary % (n)	65.8% (25)	56.8% (25)
Current Smoking / Tobacco Use % (n)	34.2% (13)	0% (0)
Current Alcohol consumption % (n)	57.9% (22)	0% (0)
Blood pressure systolic (mm Hg) *	126 ± 11.8	113.2 ± 13.3
Blood pressure diastolic (mm Hg) *	83.1 ± 8.1	75.1 ± 8.7
Family history of Diabetes	47.4% (18)	34.1% (15)
Family history + of cardiovascular disease	28.9% (11)	31.8% (14)
Family history + of obesity % (n)	42.1% (16)	38.6% (17)

* The average value based on two measurements.

+ Self-reported history in parent, grandparent or sibling

Table 2

Mean nutrient intake as reported in the food frequency questionnaire

Nutrient (n=73)	Mean ± SD
Energy (kcal/day)	3363.7 ± 1029.2
Protein (g/day)	101.0 ± 37.9
Protein density (%)	11.9 ± 1.9
Fat (g/day)	104 ± 38.8
Fat density (%)	27.7 ± 4.4
Carbohydrates (g/day)	505.1 ± 151.1
Carbohydrates density (%)	60.3 ± 5.1
Cholesterol (mg/day)	177.2 ± 114.7
Dietary fiber (g/day)	42.6 ± 12.8
Glycemic load	305.3 ± 99.1
Glycemic Index (weighted average)	64.0 ± 2.8

Data presented are means ± standard deviation.

Table 3a

Overall sensory attributes comparing different degrees of rice polishing

Polish		0% (Brown)	2–3%	4–5%	P for trend[1]
BPT Raw					
Uncooked	Color & Appearance	5.1± 2.1	3± 1.8	1.6± 1	<.0001
Plain cooked rice	Color & Appearance	5.1± 2.1	2.8± 1.6	1.3± 0.6	<.0001
Cooked rice with *sambar*	Color & Appearance	4.7± 2.3	2.5± 1.6	1.4± 0.6	<.0001
	Texture	4.6± 2.3	2.5± 1.6	1.6± 0.7	<.0001
	Taste	4.6± 2.4	2.5± 1.6	1.6± 1.2	<.0001
	Overall Quality	4.9± 2.3	2.6± 1.6	1.5± 0.9	<.0001
BPT Parboiled					
Uncooked	Color & Appearance	4.4± 2.2	2.3± 1.4	1.9± 1.5	<.0001
Plain cooked rice	Color & Appearance	4.7± 2.2	2.6± 1.4	1.6± 1.3	<.0001
Cooked rice with *sambar*	Color & Appearance	4.2± 2.2	2.1± 1.1	1.5± 0.9	<.0001
	Texture	4.5± 2.3	2.2± 1.1	1.7± 1.3	<.0001
	Taste	4.3± 2.4	2.4± 1.5	1.8± 1.4	<.0001
	Overall Quality	4.4± 2.3	2.3± 1.3	1.9± 1.4	<.0001
Uma Red Rice					
Uncooked	Color & Appearance	4.3± 2.5	3.8± 2.1	2.8± 1.8	0.0003
Plain cooked rice	Color & Appearance	4.4± 2.4	3.3± 2	2.9± 2.1	<.0001
Cooked rice with *sambar*	Color & Appearance	4.2± 2.3	3± 1.8	2.3± 1.7	<.0001
	Texture	4.1± 2.3	3.1± 1.9	2.4± 1.8	<.0001
	Taste	4.2± 2.4	3.2± 2.1	2.6± 2	<.0001
	Overall Quality	4.2± 2.4	3.3± 2.1	2.4± 1.8	<.0001

Data presented are mean scores ± standard deviation for sensory attributes based on a 7-point Hedonistic scale (1=Like Very Much to 7=Dislike Very Much).

[1] p-values based on the Kruskal-Wallis test.

Table 3b

The significance of tests for differences in sensory ratings, comparing BPT parboiled rice with BPT raw rice and BPT parboiled rice with UMA parboiled red rice at each level of polishing

Polish	0% (Brown)	2–3%	4–5%	Overall (p-value[2])
	Mean of difference (SD of difference), p-value[1]			
Uncooked Rice (color and appearance)				
- BPT Raw v.s. BPT Parboiled	0.73 (2.19), P=0.04	0.56 (1.90), P=0.01	−0.27 (1.81), P=0.34	*
- Uma parboiled red v.s. BPT Parboiled	−0.01 (2.54), P=0.69	1.44 (2.38), P<.0001	0.85 (2.09), P<.0001	*
Plain Cooked Rice (color and appearance)				
- BPT Raw v.s. BPT Parboiled	0.41 (1.64), P=0.27	0.23 (1.81), P=0.35	−0.36 (1.33), P=0.05	*
- Uma parboiled red v.s. BPT Parboiled	−0.31 (2.63), P=0.26	0.76 (2.45), P=0.01	1.21 (2.33), P<.0001	*
Cooked Rice with *Sambar* (color and appearance)				
- BPT Raw v.s. BPT Parboiled	0.40 (2.11), P=0.28	0.38 (1.41), P=0.08	−0.14 (1.01), P=0.35	P=0.10
- Uma parboiled red v.s. BPT Parboiled	0.04 (2.35), P=0.82	0.93 (2.04), P<.0001	0.78 (1.78), P=0.0006	P=0.0003
Cooked Rice with *Sambar* (texture)				
- BPT Raw v.s. BPT Parboiled	0.09 (2.29), P=0.76	0.32 (1.44), P=0.21	−0.16 (1.44), P=0.59	P=0.48
- Uma parboiled red v.s. BPT Parboiled	−0.40 (2.66), P=0.20	0.91 (2.15), P=0.001	0.61 (2.16), P=0.007	*
Cooked Rice with *Sambar* (taste)				
- BPT Raw v.s. BPT Parboiled	0.27 (2.24), P=0.58	0.15 (1.73), P=0.29	−0.22 (1.70), P=0.25	P=0.61
- Uma parboiled red v.s. BPT Parboiled	−0.13 (2.20), P=0.54	0.81 (2.34), P=0.005	0.79 (2.13), P=0.001	*
Cooked Rice with *Sambar* (overall quality)				
- BPT Raw v.s. BPT Parboiled	0.43 (2.16), P=0.21	0.28 (1.63), P=0.16	−0.42 (1.59), P=0.09	*
- Uma parboiled red v.s. BPT Parboiled	−0.16 (2.24), P=0.44	1.04 (2.13), P=0.0002	0.61 (1.80), P=0.01	p=0.008

[1] p- values based on the Kruskal-Wallis test.

[2] p-values for overall test controlling for degree of polishing (* indicating a significant interaction between degree of polishing and rice type)

Table 4

Willingness to substitute usual rice choice after taste tests (n=82)

Characteristics	Mean ± SD/ % (N)
The participant would like to substitute brown/undermilled rice for the present rice used for cooking, if made available at an affordable cost[a]	92.4% (73)
The participant will buy brown/undermilled rice, given information on health benefits of brown/undermilled rice[b]	96.3% (77)
If yes for the above question	
Will buy raw rice 0% polishing[c]	11.8% (9)
Will buy raw rice, 2.3% polishing[c]	17.1% (13)
Will buy raw rice, 4.4% polishing[c]	66.2% (51)
Will buy parboiled rice, 0% polishing[c]	5.3% (4)
Will buy parboiled rice, 2.3% polishing[c]	19.7% (15)
Will buy parboiled rice, 4.4% polishing[c]	72.4% (55)
Will buy red rice, 0% polishing[c]	22.4% (17)
Will buy red rice, 2.3% polishing[c]	2.6% (2)
Will buy red rice, 4.5% polishing[c]	25% (19)
No. of times will use brown/undermilled rice per day	1.2 ± 0.9
Will buy for the entire family	98.7% (76)
Friends and relatives of participant will use brown rice if they knew about its health benefits[b]	
Yes	86.3% (69)
No	8.8% (7)
Don't know	5% (4)
Would like to be in an intervention study to eat brown rice every day for 6 months[b]	
Yes	61.3% (49)
No	*0% (0)*
Don't know	26.3% (31)
Participation rate in Focus Group Discussion[c]	80.2% (65)

[a] N=79 due to missing values

[b] N=80 due to missing values

[c] N=81 due to missing values