Sensoric Quality of Zinc Fortified Parboiled Rice

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Abstract:

Zinc is essential for growth and development, cell mediated immunity, protein synthesis, skin and bone metabolism, enzyme function, gene expression and hormonal excretion. Zinc deficiency is a widespread problem and the present project was designed to develop zinc fortified parboiled rice for the improvement of zinc in rice.

Objective:

To develop zinc fortified parboiled rice and to determine the consumer acceptability of parboiled rice.

Methods:

Rice samples were procured. Samples were then subjected for fortification with three fortificants: ZnO, ZnSO4and mixture of both ZnO and ZnSO4. Then samples were de-husked and polished and further Analysis was carried out in Food science laboratory at University Institute of Diet and Nutritional Sciences. The collected data were statistically analyzed using Statistical Package (Costat-2003, Co-Hort, v 6.1.). ANOVA was applied for statistical analysis.

Results:

Significant differences were noted among treatments for color, flavor, texture, mouth feel and overall acceptability. Maximum color score was obtained by Mix fortified white ricei-e 8.00, flavor, texture, mouth feel is in Non-fortified white ricei-e.7.80, 8.10, 8.00 and overall acceptability score was found in White rice fortified with ZnSO4i-e8.0

Conclusions:

The fortification of zinc in rice did not appear to have a large effect on sensory acceptability with the exception of texture. Brown rice were least acceptable to consumers.

Key words:

Fortification, parboiling, zinc, consumer acceptability

Introduction:

Malnutrition is a term which refers to the imbalance of nutrients. Over nutrition is frequently seen in the developed countries where as under nutrition is common in developing countries[1]. Globally, malnutrition among young children is the most important risk for morbidity which leads to 52.5%[2]. The most common manifestations of malnutrition in developing countries are stunting, wasting and underweight[3].Young children, pregnant and lactating women are vulnerable segment of our population facing the dilemma of micronutrient malnutrition[4]. Asia is the home of children (under 5 years) with severe acute malnutrition[5]. In Pakistan, 17% of children that are below 5 years of age are malnourished[6]. Malnutrition has increased the risk of morbidity and mortality in children especially in developing countries[7]. Studies have shown that the root cause of malnutrition is poverty when people do not have enough income to buy nutritious food. Research studies have shown that micronutrient deficiency can lead to children and their mother'sdeath, physical disabilities, immune systems are weakened and their intellectual capacities were compromised[6]. Deficiency of zinc severely affects the immune system, increases the vulnerability to infection[s], growth restriction, impairs development of taste, spermatogenesis and memory in adults[8].

Deficiency of zinc can be overcomed by fortification. Fortification is a process of adding essential nutrients or non-nutrient bioactive components in food to improve health[9]. It is an excellent technique that can be used to improve the status of important micronutrients[10]. Food fortification is economical and requires less modification in the routine diet pattern, fortification of staple foods with micronutrients (i.e., vitamins and minerals) is among the three top international development priorities[10]. According to WHO, food fortification is feasible approach especially in developing countries having promising results on the target populations[11]. Rice (OryzasativaL.) is the second staple food in Pakistan having great economic worth. 90% of rice in the world is grown in South and Southeast Asia[12]. Pakistan is 13th largest producer of rice and also the 5th largest exporter. Many varieties of rice are grown in Punjab and Sindh and millions of farmers depend on the cultivation of rice as their major source of income[13]. Both fine (40%) and coarse cultivars (60%) are mainly grown in Punjab and Sindh provinces. Among the major rice varieties Super Basmati, Super Kernal, Kainat, Basmati 515, Pk-386, are cultivated to supply to the local needs as well as for export especially to the Middle East.Rice consumption in South and Southeast Asia is as high as 990g/day/person[12].

A research was conducted recently and revealed that malnutrition is also a major problem in girls as well. In rural areas of Sindh 18.3% girls and 14.6% boys were stunted. In 2005 literacy rate in women was 36% aged 15 and above. The research was conducted in 29 rural districts on a huge scale on school lunch program. They provided freshly meals in government primary girl's school for 2 years. The result was that the school enrolment was increased by 40 % and wasting was declined by almost half. They found out that there was a great scalability and success of school programs in Pakistan. Malnutrition can be decreased by working across in health, education and empowerment sector[14]. Another research was conducted on preschool children, pregnant women, school going children and lactating women and results showed that children, lactating and pregnant women in Pakistan, Sri Lanka, Nepal, Bangladesh and India were highly zinc deficient. Most practical strategies for enhancing zinc status in different population are dietary diversification, fortification and supplementation[11]. Zinc is required and involved in the activity of almost 300 enzymes. Zinc is essential for a wide range of clinical functions biochemical, and immunological. When there was acute zinc deficiency number of disturbances occurs including defects in the immune system, diarrhea, neurobehavioral changes, dermatitis, impaired growth, adverse pregnancy outcomes. When there is inadequate supply of daily zinc then intestine reduces the internal zinc excretion and the growth rate of children also decreases[15]. In a study it was found that food fortification with micronutrients such as zinc iron, iodine, and vitamin A reduces infant and child death's rate and is a very attractive preventive health care intervention[16]. Parboiling process is used to fortify rice as it has many advantages. In paddy rice crystalline form of starch is converted into amorphous form due to irreversible fusion and swelling of starch. This change is achieved by soaking in hot water and steaming. A research was conducted in which the degree of starch gelatinization, head rice yield, color value and hardness was measured. Result shows that parboiling increases gelatinization, head rice yield, color value and hardness to 46.8%–77.9%, 62.5%, 18.08–19.04 and 118.6–219.2 N[17].

Current study was conducted to develop the zinc fortified parboiled rice and determine the consumer acceptability of zinc fortified parboiled rice through sensory evaluation research so that after consuming this product the deficiency of zinc could be reduced for prevention of side effects of its deficiency.

Methods:

Fine Basmati varieties grown in Punjab were

procured from Seed Corporation Sahiwal. Paddy samples were cleaned manually to remove impurities. Rice were milled into brown and white rice which act as a standard. Similarly brown and white rice of each variety were fortified with zinc oxide and zinc sulphate at 200mg/L individually. Moreover, brown and white rice were also fortified with mixed concentration of zinc oxide and zinc sulphate at100mg/L:100mg/L. The fortified parboiled rice were prepared by dipping them in fortificant solution for 6 hours. Afterwards, paddy was steamed at 1190C for 30 min using an open container. Parboiled rice were cooled to room temperature and sun dried until 13% moisture level was achieved. After drying, paddy was de-husked into brown rice by the use of husker. Brown rice was polished into white rice in polisher[18]. Zinc fortified brown rice and white rice along with non-fortified fractions (control) were packed in the zip locked polyethylene bags for further analysis. Zinc fortified brown and white rice along with non-fortified control were subjected to sensory evaluation. Different fortified and control rice samples were cooked and evaluated by a panel of judges for general color, flavor, texture, mouth feel and overall acceptability according to the procedure described by Castiglioni S *et al*[19]. The collected data were statistically analyzed using Statistical Package (Costat-2003, Co-Hort, v 6.1.). Accordingly, level of significance was estimated by analysis of variance techniques (ANOVA) using completely randomized design (CRD). Means were further compared through Duncan Multiple Range test[20].

Results:

In B-515 rice variety the highest score (7.80±0.78) for color was found in white rice fortified with zinc oxide and the lowest score (5.50±1.72) was observed in mixed fortified brown rice. (Table 1) Among all the rice varieties highest color score (8.00±0.67) was given to PS-02 cooked as mixed fortified white rice. The lowest score (5.80±0.79) in PS-02was observed for non-fortified brown rice. In basmati Super kernel rice variety the highest score (7.90±1.14) was found for zinc oxide white rice and mixed fortified white rice and the lowest value (6.00±0.47) for color was found for zinc oxide brown rice. PS-02 mixed fortified white rice has highest score for color as zinc has been fortified but did not affect the color of the rice.

Among all the rice varieties B515 variety has greatest score (7.80±0.79) for flavor found fornon-fortified white rice and smallest flavor value (5.80±1.75)was observed for mixed fortified brown rice. In PS-02 rice variety highest flavor value (7.70±1.05) was found for zinc oxide white rice and mixed fortified white rice. Lowest flavor value (6.50±1.08) was found for zinc sulphate brown rice and mixed fortified brown rice. In Basmati super kernel rice variety maximum flavor value (7.80±0.63) for zinc sulphate white rice and mixed fortifies white rice the minimum value (6.10±1.28) for color was found for zinc oxide brown rice.

B-515 rice variety showed maximum texture value (7.30±0.95) for mixed fortified white rice Minimum texture value (5.70±0.82)was observed for zinc sulphate brown rice. The texture of PS-02 rice variety revealed highest value (7.40±1.07) for zinc sulphate white rice. Lowest texture value (5.70±0.67) was observed for non-fortified brown and white rice. Among all varieties Basmati Super kernel showed highest value (8.10±0.99) of texture for non-fortified white rice. Lowest value (5.80±0.63) for texture was found for zinc oxide brown rice. Differences were significant ($p < 0.05$). Basmati super kernel non fortified white rice had a better texture.

Among all rice varieties B-515 got the highest value (8.00±0.67) for taste found in non-fortified white rice. Lowest taste value (5.70±0.67) was observed in zinc oxide brown rice. The taste of PS-02 rice variety revealed highest value (7.40±1.35) for zinc sulphate white rice. Lowest taste score (5.60±1.50) was found for non-fortified

brown rice. In Basmati super kernel rice variety maximum mean value(7.60±0.97) for taste was inzinc sulphate white rice and mixed fortified white rice. Minimum taste (6.00±0.82) was observed for zinc oxide brown rice.B515 non fortified white rice had highest taste scoreamong ($p < 0.05$) the other varieties.

Overall acceptability of B-515 rice variety showed greatest value (7.70±0.82) for zinc oxide white rice. Lowest overall acceptability value (5.70±0.83) was observed in zinc sulphate brown rice. Among all the rice varieties PS-02 zinc sulphate white rice revealed highest value (8.10±0.83) foroverall acceptability. Lowest overall acceptability (6.10±0.78) was found in zinc oxide brown rice. In Basmati super kernel rice variety maximum overall acceptability value (8.00±0.94) wasfor zinc oxide white rice. Minimum overall acceptability (6.0±0.98) was observed in zinc oxide brown rice. So PS-02 zinc sulphate white rice had the highest value for overall acceptability.

Color	Treatment	T1	T2	T3	T4	T5	T6	T7	T8
Color	**B-515**	7.20 ± 1.03^{abcd}	6.70 ± 0.82^{abcde}	7.80 ± 0.78^{abc}	6.80 ± 0.91^{abcde}	7.20 ± 1.135^{abcd}	5.90 ± 0.567^{de}	7.20 ± 1.14^{abcd}	5.50 ± 1.72^{e}
	PS-02	6.30 ± 0.95^{cde}	5.80 ± 0.79^{de}	8.00 ± 0.67^{a}	7.20 ± 0.63^{abcd}	7.80 ± 1.03^{abc}	6.40 ± 1.5^{bcde}	8.00 ± 0.67^{a}	6.40 ± 1.51^{bcde}
	BSK	7.80 ± 1.14^{abc}	6.20 ± 0.79^{de}	7.90 ± 0.99^{ab}	6.00 ± 0.47^{de}	7.80 ± 1.14^{abc}	7.90 ± 0.99^{ab}	7.90 ± 1.14^{ab}	7.80 ± 0.99^{abc}
Flavor	**B-515**	7.80 ± 0.79^{a}	6.80 ± 0.79^{abcd}	7.30 ± 0.95^{abc}	6.20 ± 1.032^{bcd}	7.30 ± 0.95^{abc}	6.10 ± 0.87^{cd}	7.20 ± 0.63^{abcd}	5.80 ± 1.75^{d}
	PS-02	6.90 ± 0.73^{abcd}	6.90 ± 0.74^{abcd}	7.70 ± 1.05^{a}	7.50 ± 1.17^{abc}	7.50 ± 1.08^{abc}	6.50 ± 1.08^{abcd}	7.70 ± 1.05^{a}	6.50 ± 1.08^{abcd}
	BSK	7.70 ± 0.82^{a}	6.50 ± 1.27^{abcd}	7.60 ± 0.84^{ab}	6.10 ± 1.28^{cd}	7.80 ± 0.63^{a}	7.60 ± 0.84^{ab}	7.80 ± 0.63^{a}	7.60 ± 0.84^{ab}
Texture	**B-515**	6.80 ± 0.63^{abcde}	6.20 ± 0.79^{de}	7.00 ± 0.94^{abcde}	5.80 ± 0.91^{e}	6.60 ± 0.84^{cde}	5.70 ± 0.82^{e}	7.30 ± 0.95^{abcd}	6.40 ± 1.26^{de}
	PS-02	5.70 ± 0.67^{e}	5.70 ± 0.67^{e}	6.70 ± 0.48^{bcde}	6.50 ± 0.527^{de}	7.40 ± 1.07^{abcd}	6.20 ± 1.62^{de}	6.70 ± 0.48^{bcde}	6.20 ± 1.62^{de}
	BSK	8.10 ± 0.99^{a}	6.30 ± 0.95^{de}	7.90 ± 0.87^{abc}	5.80 ± 0.63^{e}	8.0 ± 0.94^{ab}	7.90 ± 0.87^{abc}	8.0 ± 0.94^{ab}	7.90 ± 0.87^{abc}
Mouthfeel	**B-515**	8.00 ± 0.67^{a}	6.90 ± 0.74^{abcd}	7.40 ± 0.97^{abc}	5.70 ± 0.67^{d}	7.0 ± 1.05^{abcd}	6.10 ± 0.99^{bcd}	7.50 ± 0.85^{ab}	5.80 ± 2.20^{cd}
	PS-02	6.60 ± 0.69^{abcd}	5.60 ± 1.50^{d}	6.90 ± 0.74^{abcd}	6.20 ± 0.42^{bcd}	7.40 ± 1.35^{abc}	6.70 ± 1.49^{abcd}	6.90 ± 0.74^{abcd}	6.70 ± 1.49^{abcd}
	BSK	7.50 ± 1.08^{ab}	6.30 ± 0.94^{bcd}	7.40 ± 1.17^{abc}	6.00 ± 0.82^{bcd}	7.60 ± 0.97^{ab}	7.40 ± 1.17^{abc}	7.60 ± 0.97^{ab}	7.40 ± 1.17^{abc}
Overall Acceptability	**B-515**	7.20 ± 0.83^{abcd}	6.40 ± 0.93^{cde}	7.70 ± 0.82^{ab}	7.00 ± 1.04^{abcd}	7.50 ± 0.81^{abc}	5.70 ± 0.83^{e}	7.40 ± 0.68^{abc}	6.30 ± 1.42^{cde}
	PS-02	6.60 ± 0.68^{bcde}	6.30 ± 0.94^{cde}	7.50 ± 1.03^{abc}	6.10 ± 0.78^{de}	8.10 ± 0.83^{a}	6.60 ± 1.21^{bcde}	7.50 ± 1.03^{abc}	6.60 ± 1.27^{bcde}
	BSK	7.90 ± 0.65^{a}	6.60 ± 1.00^{bcde}	8.0 ± 0.94^{a}	6.0 ± 0.98^{de}	7.90 ± 0.70^{a}	8.00 ± 0.70^{a}	7.90 ± 0.70^{a}	6.30 ± 1.42^{cde}

Table 1: Mean for the effect of Zn fortification on sensory evaluation of the parboiled rice

Means±S.D

Means carrying same letter in a column are statistically same ($P<0.05$)

BSK= Basmati Super Kernel

T1= White Non-fortified

T2= Brown Non Fortified

T3= fortified with 200mg/L of ZnO (white rice)

T4= fortified with 200mg/L of ZnO (brown rice)

T5= fortified with 200mg/L of ZnSO4 (white rice)

T6= fortified with 200mg/L of ZnSO4 (brown rice)

T7= Mix fortified white rice 100mg/L

T8=Mix fortified brown rice 100mg/L

Discussion:

Sensory analysis is a scientific procedure to mark sensory attributes of food by human senses like taste, smell, vision, touch, and hearing. Further, acceptance test is useful to probe the consumer behavior about foodstuffs[21]. The treatments of rice were assessed for color, flavor, texture, mouth feel and overall acceptability.

Acceptability of any food product depends upon the color of the food[22]. In the current study highest value for color was found in PS-02 mixed fortified white rice (8.00±0.67) and the lowest value was found in B515 mixed fortified brown rice (5.50±1.72). It might be because of South Asian people prefer white rice more than brown rice[22]. In another study it was found that the grain color is associated with the iron content as the rice is milled iron content decreased and there was slight change in the color of rice so rice when milled into white were more appealing to consumers than brown rice[23]. Another study reported which is similar to the current study that brown rice lack visual appeal to the consumers[24]. In the current study the highest value for flavor was given to B515 non fortified white rice (7.80±0.79) followed by PS-02 zinc oxide fortified white rice (7.70±1.05) and the lowest value for flavor was found in B515 mixed fortified brown rice (5.80±1.75). It might be because of the low intake of brown rice in Asia. Taste is influenced by the composition, textureand aroma of the food. Another similar study was conducted on the sensory evaluation on the fine basmati rice and found that well-polished rice retains its flavor for a long period of time than under polished rice because bran of the kernel contains large amount of oxidizable compounds that contribute to off flavor[22].

n the current study the highest value for texture was found in Basmati super kernel non fortified white rice (8.10±0.99) and lower texture value was found in PS-02 non fortified brown rice (5.70±0.67). A study was conducted whose results were similar with current study that I white rice has more texture (stickiness) than brown rice and in the current study most of the panelist prefer white rice over brown rice[25]. In a study sensory evaluation on the fine basmati rice was conducted and found that Basmati super showed more improvement in texture than other rice varieties. As rice was aged texture was improved because of the modification of interactions among the components of grains[22].

In the current study the highest value for taste was found in B515 non fortified white rice (8.00±0.67) and the lowest value for flavor was found in PS-02 non fortified brown rice (5.60±0.67). In the present study the highest value for acceptability was found PS-02 zinc sulphate fortified white rice (8.10±0.83) and the smallest value for the acceptability was found for B515 zinc sulphate fortified brown rice (5.70±0.83). Brown color have lacked visual appeal and apparently resulted in decreased overall quality indicating lower acceptability. All the samples had perceptible bran-like aroma, comparable cooked rice aroma and moderate sweet taste[24].

Conclusions:

This investigation showed a greater acceptability of zinc fortified rice than the control group which is non-fortified. The fortification of zinc in rice did not appear to have a large effect on sensory acceptability with the exception of texture. Zinc fortification did not affect the color, flavor and taste of rice. White rice were more acceptable to consumers than brown rice.

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