

Energy dense rice biscuit formulation to improve malnutrition status of urban street children in Bangladesh.

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Abstract

Rice is the main source of dietary energy for approximately 166 Million of Bangladeshi population. Rice based processed food items have potential scope in malnutrition mitigation approach. In this study we have formulated energy dense nutraceutically enriched rice-based bakery food formulation specially biscuits having energy density ranges from ED 4.5-5.5 per 100 g serving. Rice based balanced and nutritious food intake might reduce rice consumption from current rate of 367 g/capita/day to 300 g/capita/day or lesser for Bangladeshi population. Since floating urban street children classified as the most vulnerable group in Bangladeshi population so, nutraceutically enriched rice-based bakery food products might possibly play a role in shifting malnutrition status in this regard. In addition, in quest to attain required daily dietary allowance in scale of average 2000 kcal, rice-based energy dense food might assist as supplementary diet and it will be helpful to attain SDG goal for hunger free and sustain food security in Bangladesh in a way to properly and effectively utilizing the rice grain.

Keywords: Indigenous, Food insecurity, Nutrition, Traditional food, Country food.

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Introduction

Rice is the staple food for Bangladeshi population. At present total population of Bangladesh is about 166 Million and estimated rice production is approximately 34.7 Million Metric Tons (MMT) followed by wheat production by 1.3 MMT and corn production by 3.1 MMT (GAIN 2017) [1] among popular cereal crops in Bangladesh. Population fertility rate, population density (P/Km²) and urban population is approximately 2.19, 1278 and 60649,009 (35.3%) respectively. Since rice the staple food for Bangladeshi population so about 60-70% of total daily energy requirement is met up rice only and per capita rice consumption in Bangladesh is 367 g/capita/day [2] (BBS, 2016). Rice has free access to all class of our population from ultra-poor to rich. In citation of a report of Bangladesh Institute of Development Studies (BIDS) in 2004, a total number of street children in Bangladesh is about 0.6 million where as in 2015, the figure had reached at about 1.5 million and BIDS further predicted it will reach to 1.56 million by 2024 (Mohammed) [3]. It is a clear indication that we do not have inclusive statistics available on the actual numbers, living conditions and needs of children living on the urban streets. Since floating street children constitute one of the most vulnerable and marginal groups in Bangladesh population by different means of sexual abuse, physical torture, trauma and psychosocial disorders and diversity of the vulnerabilities, it is obligatory to take proper and effective steps to protect the children from all types of violations, to ensure their basic necessities properly especially nutritious food, to ensure their

well growth and mental development. Hakim et al. [4] in a study on health and nutritional condition of street children of Dhaka City revealed that about 65% street children are underweight, and 22.5% children eat only two times per day. Masud et al. [5] conducted a population-based survey on lives and livelihoods on the streets of Dhaka city and his data revealed that housing, food, and lack of jobs are the three most common problems for which street people are commonly sought assistance. Although there are several reports, case studies, surveys are available on street children of Bangladesh, but very little information are available regarding food formulation especially for their nutritional requirement to address malnutrition. Our aim is to intervention at this point to make a concrete step to eradicate malnutrition with formulated rice-based food items. Energy requirements of boys and girls (from 4 years to 10 years of age) ranges from 1362-1890 and 1244-1777 kcal/day according to FAO for Bangladeshi population. Nutraceutically enriched Rice-based formulated diets for floating urban street children with moderate to acute malnutrition must have some important characteristics including high content of micronutrients (Zn and Fe), high energy density (ED), adequate high protein ($\geq 10\%$) and fat content ($\geq 25\%$), low content of antinutrients, low risk of contamination, acceptable taste and texture, culturally acceptable, easy to prepare, affordable and available. We do research to formulate our rice-based products with several ingredients including rice, sago, peanut, egg, rice bran oil (RBO), salt, sugar, yeast and food grade preservatives. Since we are approaching rice-based food items so, we will explore

micronutrient (Zn, Fe, Ca, Mn and Mg) enriched and high protein content rice ($\geq 10\%$ protein) varieties in our research activities. We have to focus on energy density (ED) of formulated food. We have a target to formulate food, which will supplement at least 30-40% of total energy requirement by one meal solution, and the formulated food should be high energy density food. Since our target population is 4-10 years old floating street children, so they might need more required energy and we propose to formulate rice-based food meeting energy density ranges from 4.5-5.5 per serving. Our research findings of the study would help to policy maker, educationist, NGOs and INGOs to plan and implement the improved dietary pattern of food for the most vulnerable portion of urban population specifically our floating street children in Bangladesh.

Materials and Methods

A total of four rice flours such as BR5, BR16, BRRI dhan42, BRRI dhan43 were used in this experiment to formulate rice-based energy dense biscuits. All these above mentioned HYVs seed were collected from Genetic Seed and Resource (GRS) Division of Bangladesh Rice Research Institute (BRRI), Gazipur, Bangladesh. These HYVs have unique nutraceutical characteristics such as BR5 is reported as antioxidant enriched rice HYV in Bangladesh (Shozib et al.) [6] BR16 is the lowest GI index rice (GI value 52.4) and both BRRI dhan42 and BRRI dhan43 have maximum level of Zn content (≥ 27 ppm) and higher Fe content, higher content of water-soluble VitB1 (Thiamine) and lower amount of phytic acid at 10% polishing in unparboiled rice processing condition (Shozib et al.). [7] Rice based bakery food product specially energy dense rice biscuits were formulated according to the prescribed formulation of authors who actively took part research activities at Grain Quality and Nutrition (GQN) Divisional laboratory of BRRI, Gazipur, Bangladesh. Rice-based biscuits supposed to provide approximately 500 kcal (between 450-550 kcal) with a minimum of 10 g of protein 100 g⁻¹. Ingredients were used as mixture of rice and sago flours (8:1), vegetable fat or butter, rice bran oil, powder sugar, black seed, salt, yeast powder, peanut, milk and egg. In mixing process, all ingredients were put together for dough formation. The ingredients were fed into the planetary mixer, where they were mixed properly for 10-15 min. Mixing is followed by moulding, in which the dough is laminated into sheets and is passed down to gauge rollers and appropriate sheet thickness was achieved for cutting. Biscuits were given a variety of shapes and sizes using cutter. In Baking process, moulded biscuits are put into the baking oven rack on 190°C for 30 min. After baking biscuits, they were passed on to cooling conveyors for natural cooling prior to packing. We preferred natural cooling to force cooling as it helps to maintain the texture quality of biscuit. Energy dense rice biscuits (EDRBs) were analyzed for proximate composition analysis such as carbohydrate, fat, protein, moisture, dietary fiber and ash according to AOAC methods to estimate energy in kcal for 100 g serving. Micronutrients such as Zinc, Iron, Calcium and heavy metals such as Arsenic, Lead, Cadmium, Nickel were measured by Atomic Absorption Spectrophotometry

(Shimadzu, Japan. AAS-6800) using both flame and graphite furnace AAS methods. Macronutrient such as Phosphate was measured by spectrophotometric method. All test parameters were conducted trice at GQN laboratory in BRRI, Gazipur, Bangladesh.

Results and Discussion

Considering the nutritional status index of Bangladesh which is tabulated in Table 1, nutraceuticals enriched food intake seems necessarily require for our population especially vulnerable group such as urban street children. EDRB contains higher Zn, Fe, P and Ca which physiologically improve the body activity and metabolism. As per standard protocol of Bangladesh Standard Testing Institute (BSTI) [8-10], Bangladesh, any biscuit should not contain heavy metals such as As, Pb, Cd and Ni more than 0.01 ppm. We had tested our EDRB in detail chemical analysis and found suitable for human consumption as nutritional analysis reveals a very energy dense (ED) biscuit which produces 515 kcal energy for 100 g serving at ~6-7 biscuits of ~15 g weight each.

Table 1. Nutrition Index of Bangladesh [9,11,12].

Nutrition Index of Bangladesh (All data are presented in percentage% along with source)		
Stunting	36.0	Bangladesh demographic and health survey, 2014
Wasting	14.0	Bangladesh demographic and health survey, 2014
Low weight	33.0	Bangladesh demographic and health survey, 2014
Anemic female	26.0	National Micronutrient survey, 2011
Anemic (under 5 years of age)	33.1	National Micronutrient survey, 2011
Zn deficiency (under 5 years of age)	44.6	National Micronutrient survey, 2011
Zn deficient female	57.3	National Micronutrient survey, 2011
Iodine deficient female	42.1	National Micronutrient survey, 2011
Adult Diabetes patient	6.89	International Diabetes federation, Diabetes Atlas, 2014
Overweight (BMI >25)	39.0	Food Security and Nutritional Surveillance Project, 2013
Adult High Blood pressure	13.5	Regional health forum, 2013

In Figure 1, We have shown proximate analysis of EDRB and found 57% carbohydrate, 27% fat, 10% protein, 3.4% moisture, 1.2% dietary fiber and 0.8% ash including all minerals and vitamins. EDRB also contains a good amount of Zn, Fe, Ca and P. The four rice flours were mixed 1:1:1:1 ratio hence we expected the combined phytic acid content would be lower than individuals would as reported in earlier report Shozib et al. [8] Bioavailability of minerals will be higher in

this regard. Since rice do not have gluten protein so the main challenges rely on getting acceptable commercial biscuit texture and rice bakery products trends to creak down as lack of elasticity. We tried several natural lubricant agents in this regard such as sago powder, aloe-vera plant extracts, barley etc. (data are not shown) and found sago powder suitable in getting biscuit texture. Bangladesh Standard Testing Institute (BSTI) standardized protein rich wheat biscuit as reference in BDS 1563:2011 by 2nd revision where BSTI recommended to follow few mandatory properties regarding high protein biscuits such as protein% ($\geq 10\%$), moisture ($\leq 4.5\%$), fat ($\geq 20\%$) and heavy metal such as Arsenic (As), lead (Pb), Cadmium (Cd) and Nickel (Ni) concentration should be less than 0.01 ppm. In our experiment, we have considered the above-mentioned recommendation and formulated EDRB accordingly (Figure 1).

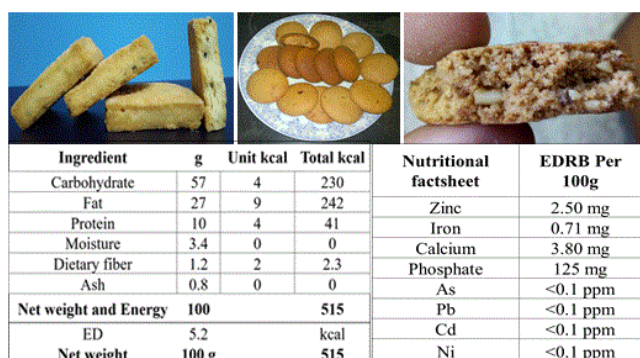


Figure 1. Rice based bakery products such as EDRB with its proximate composition and nutritional fact sheet.

Baking condition was maintained at 180°C for 30 mins. at rotary rack oven. In AAS analysis, we did not find elevated level of any heavy metals in EDRB. Energy density (ED) was found ~5.2. A 100 g of serving of EDRB might provide 515 kcal energy, which higher than wheat based high-energy biscuit of World Food Program (WFP) where ED is around 4.5. We were aim to formulate rice based EDRB which might potential to replace wheat-based biscuit in Bangladesh as wheat is not so popular cereal crop and we have to spend a good amount of foreign currency to import major portion of wheat for consumption. According to FAO, as we mentioned earlier that energy requirements of boys and girls (from 4 years to 10 years of age) range from 1362-1890 and 1244-1777 kcal/day for Bangladeshi population. If we able to introduce EDRBs through any governmental organization, NGO or INGO, targeting these floating street children age between 4 to 10 years considering both boys and girls then approximately 38-27% and 41-29% of daily energy requirement can be made available respectively by simply 100 g of serving EDRBs a day. In Figure 2, Sensory evaluation form was described to evaluate Energy dense rice biscuit (EDRB) and the sensory evaluation test was conducted on 60 healthy individuals including male and female age ranges from 5 to 50 years of age as human subjects at BRRI.

Rating Scale	Appearance	Taste	Texture	Smell	Overall Acceptability.
9. Like Extremely					
8. Like very much					
7. Like moderately					
6. Like slightly					
5. Neither like or Dislike					
4. Dislike slightly					
3. Dislike moderately					
2. Dislike very much					
1. Dislike extremely					
Office use only					
Panelist Code				Date	

Figure 2. Sensory Evaluation Form Recipe Name: Energy Dense Rice Biscuit (EDRB) Directions: check () one rating for each of the following: Appearance, Taste, Texture, Smell and Overall acceptability.

Exclusion criteria were smoking, drug addiction, viral flu and medication (antibiotic). Overall acceptability of EDRB was graded as average score of 7.5 (98%) which resembled as liked and it includes rating score from 6 to 9 as Like Slightly (7%), Like Moderately (30%), Like very much (52%) and Like Extremely (9%) of the participants considering all parameters such as appearance (98%), taste (98%), texture (93%) and smell (82%) into account (Data not shown). EDRB can potentially be used as nutritious diet supplement for floating urban street children to improve their malnutrition status. Our rice based EDRB can be an ideal nutritionally enriched food supplement which is also a low-cost diet as 100 g serving of EDRB and it will not cost more than 0.12 USD or 10.00 BDT currency.

Conclusion

Rice based bakery product specially rice biscuits have potentiality to be used as energy dense rice biscuit alias EDRB (ED 4.5-5.5) in malnutrition mitigation program in Bangladesh for vulnerable groups of floating urban street children specially and EDRB can further be considered as emergency relief dry food materials for refugee and disaster related humanitarian operation.

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