Formulation of Rice Based Low Cost Balanced, Nutritious and Safe Diet for the Malnourished Street Children in Capital City Dhaka

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Abstract

A total of 384 street children were subjected to study a baseline survey aged from 4 to 12 years old in Capital City, Dhaka. The sample size was fixed by addressing Cochran equation. Among the respondents 63% were male and 37% were female from street children population of 384. Survey took place at 20 different hot spots covering both Dhaka city north and south. We have observed the recommended dietary intake per day from 4 years to 12 years old male boys and found 27 to 59% deficiency in our male population samples of 243. Similarly, we also observed the recommended dietary intake per day from 4 years to 12 years old female girls and found 28 to 56% deficiency in our female population samples of 141. Since our Energy Dense Rice Cake (EDRC) has a potential of providing 500 kcal energy per 100g serving so, we could predict that incorporating our improved rice-based product once a day along with their daily regular intake, it will able to mitigate nutritional gap by 64 to 100% for street boys and noticeably 70 to 100% for girls. We have prepared Energy Dense Rice Biscuit (EDRB, 3.6% moisture, 515 kcal per 100g of serving) and EDRC (5.0% moisture, 500 kcal per 100g of serving). EDRC was found prepared than EDRB in impact study when the respondents were given choice of rice-based bakery items intake for four months long period. Finally, a total of 32 respondents were took part in a four months period impact study on EDRC from street children population. All anthropometric and biochemical data such as CBC (Complete Blood Count), Hemoglobin, CRP, Prealbumin etc. were collected at both the starting (Day 0) and the end time (Day 120) of the impact survey of selected 32 respondents. Respondents were given 100g serving of EDRC every day (rice cake) to 32 street children samples for 4 months period along with their normal food intake. Our data revealed that malnutrition related parameters specially CRP (decreased) and Prealbumin (Increased) are significantly improved during four months supplementary intake of extra 500 kcal per 100 g serving of EDRC in tested street children's samples which resembles the possible impact of EDRC on street children. Rice-based bakery products specially EDRB and EDRC can potentially be used in school feeding nutritional program and disaster management in Bangladesh.

Keywords: Energy Dense Rice Biscuit; Impact Study; Baseline Survey; Prealbumin; Formulated Food

Abbreviations

EDRB: Energy Dense Rice Biscuit; EDRC: Energy Dense Rice Cake; ED: Energy Density; AAC: Apparent Amylose Content; GT: Gelatinization Temperature; OAC: Oil Absorption Capacity; WAC: Water Absorption Capacity

Introduction

In a street children consortium on promoting and protecting the rights of street children at Colombo, Srilanka back in 2001, Aparajeyo Bangladesh, for the first time bring the statistics that the estimated number of street children was 445226 in Bangladesh of which 75% were in Dhaka city and frequency were 53% boys and 47% girls [1]. Bangladesh Institute of Development Studies (BIDS) had reported in December 2004, a total number of street children in Bangladesh was 6, 74,178 [2]. In 2015, according to BIDS, the number becomes 1.5 million and it will reach to 1.56 million in 2024 [3]. Rural-urban migration is one of the major reasons of the exposure of the street children to the vulnerabilities. Considering the increasing trend of street children and diversity of the vulnerabilities, it is very much necessary to take proper and effective steps to protect the children from all types of violations, to ensure their basic necessities properly, to ensure their well growth and development. The given situation clearly reveals that there are no comprehensive and reliable statistics available on the actual numbers, living conditions, needs and interests of children living on the streets. But the fact is street children constitute one of the most vulnerable and marginal groups in Bangladesh. Hakim, et. al., 2016 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 in a day [4]. Masud Ahmed, 2011 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 [5]. 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. Since rice is an important source of energy, hypoallergenic, easily digested, providing protein with higher nutritional quality and has versatile functional nutraceutical properties [6] so, rice based low cost balanced, nutritious and safe diet formulation will able to address malnutrition related problems of the vulnerable section of our population especially urban street children. Among cereals, rice do not have gluten protein. Since gluten protein of wheat and maize cereals produce hypersensitivity reaction to human and we do not have multiple opinions other than consuming rice only so, rice-based food items such as rice cookies, rice ball, rice cake, rice noodles can be formulated at lower cost but higher nutritious value. We were aimed to formulate low cost and nutritionally balanced rice-based food items from nutritionally enriched selected brown and pre-germinated brown rice varieties. Finally, we had a plan to operate a volunteer promotion scheme of rice-based food items with multiple options for the malnourished children in urban city Dhaka. The small amount of quality rice-based products intake will reduce the consumption of rice intake gradually in Bangladesh. Street children problem in Bangladesh are social phenomena which also be given importance to enhance social and economic justice and equity. Our population target is children at age of 4 to12 years and their daily recommended dietary intake (RDI in kcal of energy) requirements of boys and girls (from 4 years to 12 yrs. of age) ranges from 1303-2200 and 1202-2070 kcal/day according to FAO for Bangladeshi population [7,8]. Rice based formulated diets for street children with moderate to acute malnutrition must have some important characteristics including high content of micronutrients, especially growth (type II) nutrients, high energy density, adequate high protein and fat content, low content of antinutrients, low risk of contamination, acceptable taste and texture, culturally acceptable, easy to prepare, affordable and available. We had tried to formulate our rice-based products with several ingredients including rice, egg, rice bran oil (RBO), salt, sugar etc. We had to focus on energy density of formulated food. If the energy density is too low, the food becomes too bulky, and the children will not be able to eat adequate amounts. We have a target to formulate food which will supplement at least 30% of total energy requirement by one meal solution and the formulated food should be high energy density (ED) food. Energy density is the ratio of energy per weight of food. The energy density is most important for children with wasting, as they have an increased energy need for catch-up growth. The most important factor influencing energy density is the fat content, as the ED of fat (9 kcal/g) according to the Atwater factors is more than double that of protein and carbohydrate (4 kcal/g). Another important factor is the water content. Since our target population is 4 - 12 years old street children, so they might need more required energy and we propose to formulate rice-based food meeting energy density (ED) ranges from 4.5 - 5.5 for single dose meal. Our objectives of the study were I. Baseline survey on street children in Capital City Dhaka to understand the required calorie gap, II. Formulation of rice-based energy dense bakery food items and III. Impact evaluation study on energy dense rice biscuit (EDRB) food on street children.

Materials and Methods

Baseline survey on street children in capital city Dhaka

Street children are the vulnerable group of children coming to fight to gild the streets for their habitual abode and livelihood drifted into a nomadic life. These children are generally malnour-

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ished due to their deprivation on health and improved nutrition. Our plan was to nourished children from malnourished. To plan a need-based information is essential on their dietary pattern of street children. A baseline survey was done on 384 samples of the target population (street children in Dhaka City) to fill in this knowledge gap.

Study areas

A total of 20 study areas including all previously reported hot spot areas of street children in Dhaka City were accounted for conducting the baseline survey such as Shahbagh (Poribagh and shishu park area), Ramna (Dhaka University promises), Karwan Bazar, Kamlapur (Rail station area), Tejgoan (Industrial area), Agargoan (IDB Bhabon to Shamoli shishumela), Azimpur (Newmarket and graveyard), Baily road area, Shadorghat (Terminal area), Gulistan (Stadium area), Syedabad (Bus station area), Khilgoan (nearby Fly-over area), Muhammadpur (Market and bus stand area), Mohakhali (Tangail bus stand to ICDDRB area), Mirpur 2 (Stadium area), Gabtoli (Bus station area to technicalmore), Uttara (Jasimuddin to house building area), Gulshan (circle 1 to circle 2 area), Moddo Badda (link road area), Rampura (Aftabnagor and Bonosri area).

Target population

Since street children are the most vulnerable group of children coming to fight to gild the streets for their habitual abode and livelihood drifted into a nomadic life. These children are generally malnourished due to their deprivation on health and improved nutrition. Our target population is both boys and girls of age from 4-12 years old street children.

Sampling and sample size

We have interviewed 384 street children from above mentioned 20 hot spots. Using Cochran Equation, we find the sample size:

$$\text{Sample size} = \frac{z^2 \, P \, (1 - P)}{E^2}$$

The value of Z is found in statistical tables which is contain the area under the normal curve. Z = 1.96 for 95% level of confidence. P is the estimated proportion of an attribute that is present in the population.

E^2 is the desired level of precision.

$$\text{Sample size} = \frac{1.96^2 \times 0.5 \times (1 - 0.5)}{0.05^2} = 384.16 \cong 384$$

Development of tools

A semi-structured questionnaire was developed to collect data through face-to-face interview with the respondents. The ques-

tionnaires were pre-tested in areas outside our sample and were revised on the basis of feedback received from field-testing. The quantitative questionnaires mainly covered diverse information of study respondents such as socioeconomic and demographic characteristics, current living conditions and livelihood activities, morbidity and health-seeking behavior, dietary intake pattern, and education and drug uses, and anthropometrical measurement such as body weight and height, BMI, waist and hip circumferences ratio, mid-arm circumference. Since we were aimed to focus mainly in daily energy intake of street children in our baseline survey so we had considered their Calorie information for this paper only.

The survey

An instruction manual explaining the key terms in the questionnaire were developed and given to the enumerators. On the day of interview, the team identified the first respondent according to the definition of street dwelling child population and criteria for selection. The study included only those who will show interests on volunteer basis. Verbal consent will be taken before starting the interview. The field activities were supervised by the authors. Quality controls were measured accordingly. Before launching the actual study, all the techniques and tools were tested and modified under pre-testing. Enumerators were given extensive training, both in the classroom and in the field setting until the researchers were convinced about their abilities in collecting and managing data effectively and consistently. A field guideline detailing the definitions used, identification of prospective respondents, the steps to be followed during data collection, and trouble-shooting measures will be prepared for the data collectors. Effective and supportive supervision should ensure on a continuous basis. The investigators supervised the data collection and verified the validity, accuracy and completeness of data through on-the-spot checking. Regular feedbacks were given to the enumerators for maintaining an acceptable level of data quality. Regarding ethical issues, all respondents were informed about the purpose of the study and their verbal consent will obtained before taking interviews. All information will be kept anonymous and confidential. Data management and analysis: The questionnaires were checked in the field by the supervisors for any inconsistency and incompleteness.

Formulation of rice-based energy dense bakery food items

Our population target is children at age of 4 to 12 years and their expected weight ranges from 16.71 to 34.38 kg for boys and 16.0 to 37.0 kg for girls at Bangladesh population standard including both sexes [7]. We have formulated our rice-based products with several ingredients including Rice flour (Selective), sugar, skimmed milk, egg, vanilla essence, grinded sagu powder and extract of aloe vera as lubricating agent, butter, yeast powder, Rice Bran Oil (RBO) and vegetable edible oil. The metabolizeable energy values of all

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formulated foods ingredient was given in kilocalories (kcal). The energy values have to be calculated based on protein, fat, available carbohydrates and fibre values and by applying the energy conversion factors such as kcal/g 4; 9; 4 and 2 kcal respectively. Since rice flour does not have gluten protein unlike wheat, so making dough was seeming difficult to get appropriate texture in reality. We had tried to overcome the problem with few measurements such as Unparboiled milled rice were treated for one hour soaking in water at room temperature before grinding into flour, Both low Apparent Amylose Content (AAC) and Gelatinization Temperature (GT) rice flour were mostly suitable for rice-based bakery products, Flour parameters such as Oil Absorption Capacity (OAC), Water Absorption Capacity (WAC) and forming activity etc. would be considered at flour quality selection, Sheaving flour to attain unique flour size is a necessary step and Sagu, casava and aloe vera can potentially be used as thickening, stabilizing, suspending, and binding agent.

Proximate analysis of energy dense rice-based bakery product

- **Estimation of protein:** Standard micro Kjeldahl procedure of AOAC [9] were used for the determination of nitrogen and crude protein were estimated by multiplying the nitrogen content by a factor 5.95 for rice flour and 6.25 for egg.

- **Moisture:** Moisture content were determined by AOAC method [9].

- **Dietary fibre (g)/crude fibre:** Dietary fiber were determined by AOAC method 2000 [10].

- **Ash (g):** Ash content of grain were estimated by heating the dried raw sample in a Muffle furnace at 600°C to burn out all organic materials for 3-5 hours till to constant weight. The inorganic residue will be quantified as the ash content by AOAC method 2000 [11].

- **Estimation of Fat:** Fat were extracted from the grounded rice samples with Chloroform: Methanol (2:1) solution. Fat was determined from the extract by the method of Choudhury and Juliano [12].

- **Carbohydrate (g):** The carbohydrate content of a sample was calculated by subtracting the percentage of other components of that sample (moisture, ash, fat, protein and fiber) from 100. Percentage of carbohydrate = 100 - (moisture + ash + fat + protein + fiber).

- **Estimation of Minerals and Heavy metals:** Minerals (Zn, Fe, Ca) and heavy metals (As, Pb, Ni and Cd) were estimated in AAS by method of the Association of Official Agricultural Chemists, AOAC, 2019 [13]. National Institute of Standards and Technology (NIST) reference material Rice flour NIST SRM 1568b SIGMA-ALDRICH, USA was used for mineral and heavy metal estimation in Atomic Absorption Spectro-

photometer (AAS) [14]. Estimation of phosphorus was carried out by measuring calorimetrically the blue color formed when the ash solution was treated with ammonium molybdate and the phosphomolybdate thus formed was reduced [15].

- **Blood chemistry:** CBC (Complete Blood Count) including Hb%, TWC (Total White cell count), RBC (Red Blood Cell Count) were analyzed by automated hematology analyzer (Brand: Landmark Biomedicals). Serum levels also decline in patients with conditions associated with protein malnutrition, such as malignancy, cirrhosis, protein-losing enteropathy, and zinc deficiency. Serum Prealbumin was estimated by Human Prealbumin ELISA Kit (ab231920) [16].

Impact evaluation study on energy dense rice food product on street children

Formulated foods such as EDRC and EDRB were prepared based on the calorie gap between recommended calorie intake and actually calorie intake for the age 4 to 12 years for both sexes. Regarding impact evaluation we have divided our required samples (Total 52 samples; 32 samples for treatment: 20 for control into two groups. Treatment groups (having formulated rice-based foods for four months' time) and control group (without formulated rice-based foods). These two groups were selected using propensity score matching [17]. Test group children used to gather in an open school for spending one hour time while intaking the supplied EDRC and their activities were routinely digitally monitored. Then mean difference in different parameters were analyzed by Independent t test and paired t test in R Version 4.02 and we were able to come to a decision whether this special supplementary diet can improve present status of the street children or not.

Results and Discussion

Baseline survey on daily Calorie intake of street children in capital city, Dhaka

A total of 384 street children were subjected to interview for baseline survey on their present Calorie (kcal) intake per day. RDI for 4 - 12 yrs. Boys and Girls are ranged from 1303 - 2200 kcal and 1202 - 2070 kcal respectively. Our survey data revealed that 27-59% gap or deficiency of RDI prevailed in Boys population (Table 1) and 28 - 56% gap of RDI for Girls population (Table 2). We have predicted while our ongoing baseline survey that if we can produce to supplement 500 kcal by 100 g serving once a day then minimization of RDI gap can be 38-100% and 56 -100% for Boys and Girls of 4-12 yrs. Respectively (Table 1 and 2). Z-score can identify and pinpoint deterioration in weight and height of children in reference to the children of same age and sex. Z-score is more accurate and reliable way of presenting prevalence data in population level sur-

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veys. In Z score analysis considering Weight for Age condition, less than -2σ score is classified as underweight, score between-2σ to -3σ classified as moderate underweight and more than -3σ score classified as severe underweight. On the other hand, in Z score analysis considering Height for Age condition, less than -2σ score is classified as stunting, score between-2σ to -3σ classified as moderate stunting and more than -3σ score classified as severe stunt-

ing [18]. Our data revealed that both boys and girls for Weight for Age and Height for Age were less than -2σ score which classified as underweight and stunting population of 4-12 yrs. in our current baseline survey for street children respectively (Figure 1 and 2). In our statistical data analysis, less than 5th percentile were used to define shortness and low weight-for-length of our target population for both Boys and Girls of 4-12 yrs.

	Age	RDI In Kcal	Observed Data Ranges in Kcal	Observed Average Data in Kcal	RDI % intake	Gap In Kcal	Gap % of RDI	EDRB Kcal per100g serving	EDRB Provide RDI%	Gap % of RDI % Remain	Predicted Kcal gap Minimization of RDI%
Male	4 (n = 13)	1303	600-1100	955	73	348	27	500	38	-11	100
	5 (n = 11)	1362	630-1210	865	63	497	37	500	37	0	100
	6 (n = 14)	1403	670-1180	852	61	551	39	500	36	3	92
	7 (n = 21)	1507	720-1187	994	66	513	34	500	33	1	97
n = 243	8 (n = 20)	1624	620-1170	919	57	705	43	500	30	13	70
	9 (n = 35)	1750	620-1250	865	49	885	51	500	28	23	55
	10 (n = 32)	1890	670-1300	877	46	1013	54	500	26	28	48
	11 (n = 40)	2038	620-1400	866	42	1172	58	500	24	34	41
	12 (n = 57)	2200	650-1280	893	41	1307	59	500	23	36	38
	EDRB: Energy dense rice biscuit; ED: Energy Density: RDI: Recommended dietary intake										

Table 1: Baseline survey on daily dietary intake of street children (age 4-12) for boys.

	Age	RDI in Kcal	Observed Data ranges in Kcal	Observed (Average) data in Kcal	RDI % intake	Gap In Kcal	Gap % of RDI	EDRB/EDRC Kcal per100g serving	EDRB/ EDRC provide RDI%	Gap % of RDI% Remain	Predicted Kcal gap minimization of RDI%
Female	4 (n = 12)	1202	625-1110	898	72	346	28	500	41	-14	100
	5 (n = 19)	1244	700-1300	850	68	352	32	500	41	-14	100
	6 (n = 11)	1300	658-1020	769	59	531	41	500	38	3	93
	7 (n = 28)	1403	620-1180	884	63	519	35	500	37	-2	100
n = 141	8 (n = 11)	1502	820-1210	1002	67	500	33	500	33	0	100
	9 (n = 13)	1638	672- 970	767	47	871	53	500	30	23	56
	10 (n = 15)	1777	670-1170	931	52	846	48	500	28	29	60
	11 (n = 21)	1942	650-1025	863	44	1079	56	500	26	30	54
	12 (n = 11)	2070	850-1270	930	45	1140	55	500	24	31	56
	EDRB: Energy dense rice biscuit; ED: Energy Density: RDI: Recommended dietary intake										

Table 2: Baseline survey on daily dietary intake of street children (age 4-12) for girls.

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Figure 1: Percentile and Z-Score of Boy's population (n = 243) Height for Age and Weight for Age.

Figure 2: Percentile and Z-Score of Boy's population (n = 141) Height for Age and Weight for Age.

Formulation of low cost, nutritious and safe rice-based food

Since rice flour does not have gluten protein unlike wheat, so making dough or batter was seemed difficult to get appropriate texture in reality. We had tried to overcome the problem with few measurements such as follows, i. Un-parboiled milled rice was treated for one hour soaking in water at room temperature before grinding into flour, ii. Parboiled rice was used for rice-based bakery products (Figure 3A-3C) subjected to low Glycemic rice products only and in other case un-parboiled milled rice will be uses for bakery purposes, iii, Both low apparent amylose content (AAC) and gelatinization temperature (GT) rice flour were considered suitable parameters for rice-based bakery products., iv, Rice flour parameters such as oil absorption capacity (OAC), water absorption capacity (WAC) and forming activity etc. were also considered at flour quality selection, v. Sheaving flour to attain unique flour size was a necessary step and sagu, casava and aloevera can potentially be used as thickening, stabilizing, suspending, and binding agent. Ingredients of ERDB and EDRC were rice flour, sugar, skimmed milk, egg, vanilla essence, grinded sagu powder as lubricating agent, butter and RBO. Bangladesh Standards and Testing Institute (BSTI) is the prime standardizing authority in Bangladesh for food quality control. Since BSTI did not have currently rice standards but wheat flour only so, we formulated rice-based biscuit with reference of high protein wheat biscuit prescribed by BSTI and tried to fortified fat content which formulated first time in Bangladesh. Our energy dense rice biscuit (EDRB) and cake (EDRC) had energy density ranges from 5.0-5.15 which means per 100 g serving EDRB and EDRC can generate 515 and 500 kcal respectively (Table 3 and 4). According to BSTI minerals such as Zn, Fe, Ca Phos. and heavy metals such as As, Pb, Cd and Ni were supposed to be quantify and check the presence in rice-based products respectively. We quantified all required minerals and checked the presence of heavy metals in our products (Table 3 and 4). For our products we used, 57-59% carbohydrate from rice flour and sagu powder together, then 25 to 27% fat from Rice bran oil and butter together, then 10 to 10.6% protein from milk, egg together (Table 3 and 4). Proportionate use of sagu powder mixed with rice flour gave good bakery texture for rice biscuit and cake as sagu powder served as binding agent. Rice-based formulated diets for children with moderate to acute malnutrition must have some important characteristics including high content of micronutrients, especially growth (type II) nutrients, high energy density (defined as the ratio of energy per weight of food), adequate high protein and fat content, low content of anti-nutrients, low risk of contamination, acceptable taste and texture, culturally acceptable, easy to prepare, affordable and available. High energy density rice is most desirable for children with wasting, as they have an increased energy need for catch-up growth. The most important factor influencing energy density is the fat content, as the energy density of fat (9 kcalg^{-1}) according to the Atwater factors is more than double that of protein and carbohydrate (4 kcalg^{-1}). A major factor constraining accessibility of poor is price volatility. As the poor spend a relatively larger proportion of their income in basic stables, a sudden spike in price is equivalent to reduction in their real incomes. This will constrain their ability to acquire adequate quantity of staples. Considering this fact into account, our formulated products will not cost more than $0.10 USD or 8.5 BDT (Bangladeshi Taka) for 100g serving which supposed to be cost effective.

Impact evaluation study of rice based formulated food on street children

Our population target is children at age of 4 to12 years and their expected weight ranges from 16.71 to 34.38 kg for boys and 16.0 to

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Proximate components	Amount in g	Kcal^{-1}g	Estimated Kcal	Minerals	Amount $^{-1}$100g
Carbohydrate	57	4	228	Zn	2.50 mg
Fat	27	9	243	Fe	0.71 mg
Protein	10.6	4	42.4	Ca	3.80 mg
Dietary Fiber	1	2	2	Phos	125 mg
Ash	0.8	0	0	As	<0.1 ppm
Moisture	3.6	0	0	Pb	<0.1 ppm
Net weight	100	-	515.4	Cd	<0.1 ppm
Energy Density (ED)	5.2	-	515 Kcal	Ni	<0.1 ppm

Table 3: Proximate analysis of EDRB (Energy dense rice biscuit).

Proximate components	Amount in g	Kcal^{-1}g	Estimated Kcal	Minerals	Amount $^{-1}$100g
Carbohydrate	59	4	236	Zn	2.30 mg
Fat	25	9	225	Fe	0.51 mg
Protein	10	4	40	Ca	3.60 mg
Dietary Fiber	0.5	2	1	Phos	115 mg
Ash	0.5	0	0	As	<0.1 ppm
Moisture	5.0	0	0	Pb	<0.1 ppm
Net weight	100	-	502	Cd	<0.1 ppm
Energy Density (ED)	5.02	-	502 Kcal	Ni	<0.1 ppm

Table 4: Proximate analysis of EDRC (Energy dense rice cake).

37.0 kg for girls at Bangladesh population standard including both sexes (from 4 years to 12 yrs. of age) ranges from 1303-2200 and 1202-2070 kcal/day according to FAO for Bangladeshi population [7,8] which requires 78 to 64 kcal/kg/day for boys and 75 to 56 kcal/kg/day for girls respectively (from 4 years to 12 yrs. of age) as FAO reference [8]. A total of 52 respondents including 32 testing and 35 controls samples of both sexes were keep in impact study of formulated food (Rice based cake or biscuit) on street children. We have set up a free one-hour schooling at our project field at Uttara near the Turag river side. where informal education was given for 4 months. We tried to monitor that the serving amount of 100g equivalent rice cake were properly intake by selected 32 volunteers or respondents at daily basis. In order to monitor our feeding activities, we have to set up this type of field school temporarily. Blood samples were taken at day 0 as initial and 100g of serving per day formulated food (Rice based cake or biscuit) were given to 32 testing samples every day for 4 months' time without hampering their normal food intake. On the other-hand controls were not feed the similar amount of 100g of serving per day formulated food (Rice

based cake or biscuit) but keeping them on their usual intake of food. Control group for 20 street children were subjected to draw the blood samples as initial too. At the end of 4 months' time blood samples from both samples and controls were taken for comparison of blood parameters specially CBC (Complete Blood Count), Hemoglobin, CRP and Prealbumin. Blood parameters related to malnutrition such as CBC (Complete Blood Count), Hemoglobin, CRP and Prealbumin were collected at both the starting and the end time of the impact survey of selected 52 respondents including testing and control samples. In impact study at day 0, fifty-two (52) respondent including 32 testing samples and 20 control samples were subjected to draw blood samples for estimating several malnutrition related blood parameters such as CBC (Complete Blood Count), Hemoglobin, CRP and Prealbumin were examined. These respondents also subjected for their daily Calorie intake baseline survey at day 0. From that onwards, a supplementary energy dense rice cake (EDRC) having ED 5.0 was distributed among 32 testing samples for 120 days or 4 months duration without interfering their regular food intake. Since testing samples were given 500 kcal supplements so at the end of the 4-month time their daily energy intake found higher than control group which reflects in overall improvement in blood parameters such as increased Hb%, Total White cell count (TWC), Red blood cell (RBC), Prealbumin and decreased CRP protein. Our data revealed that the Deficiency of RDI% in our population street children for respective age group were improved by 70-100% at day 120 for taking supplementary rice-based food once a day (Table 5). Before starting the impact study, our target samplings for both control (n = 20) and treatment groups (n = 32) were checked statistically by Independent t test at day 0 (α = 0.05) since there was no mean difference between control and treatment group at day 0 for hemoglobin, TWC, RBC, CRP and Prealbumin (Table 6). Null hypothesis for the mean differences between the before and after treatment at day 120 for hemoglobin, TWC, RBC, CRP and Prealbumin were found significant by Paired t test (α = 0.05) (Table 7). Finally, Null hypothesis for measuring mean difference between control and treatment group at day 120 for several blood parameters such as hemoglobin, TWC, RBC, CRP and Prealbumin were found significant by Independent t test α = 0.05 (Table 8). All statistcal analysis clearly indicate that there was a significant improvement in treatment or testing group compared to control grooup. EDRC can potentially be used in school feeding nutrition program and disaster mangement including refugee crisis, flood or cyclone related emergency relief operation program to mitigate malnutrition and emergency response of energy dense dry food as suppliments. Thus we can attain SDG goal 2.0 (Zero hunger) specially 2.1 goal which deals with a vision to end hunger and ensure access by all people, in particular the poor and people in vulnerable situations, including infants, to safe, nutritious and sufficient food all year round.

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Name	Age	Gender	Daily Energy at 0 day (Observed) kcal/day	Age based RDI kcal/day	Deficiency %	EDRC kcal/day	Daily Energy at 120 day (Observed) kcal/day	Deficiency %	Deficiency status improved
Rohita	5	Female	880	1202	26.8	500.0	1380	-14.8	100
Hasan	5	Male	1160	1362	14.8	500.0	1660	-21.9	100
Siam	6	Male	1180	1403	15.9	500.0	1680	-19.7	100
Samia	6	Female	1290	1300	0.8	500.0	1790	-37.7	100
Lamia	6	Female	1210	1300	6.9	500.0	1710	-31.5	100
Fahima	6	Female	1240	1300	4.6	500.0	1740	-33.8	100
Mim	6	Female	1230	1300	5.4	500.0	1730	-33.1	100
Shohid	6	male	1130	1403	19.5	500.0	1630	-16.2	100
Itila Akter	6	Female	1030	1300	20.8	500.0	1530	-17.7	100
Yeasin	7	Male	1280	1507	15.1	500.0	1780	-18.1	100
Sakib	7	Male	1280	1507	15.1	500.0	1780	-18.1	100
Jhuma	8	Female	1280	1502	14.8	500.0	1780	-18.5	100
Tinni Akter	8	Female	1080	1502	28.1	500.0	1580	-5.2	100
Mahfuj	8	Male	1340	1624	17.5	500.0	1840	-13.3	100
Susmita	8	Female	1230	1502	18.1	500.0	1730	-15.2	100
Maria	8	Female	1230	1502	18.1	500.0	1730	-15.2	100
Mehedi Hasan	9	Male	1080	1750	38.3	500.0	1580	9.7	92.3
Irin Akter Shila	9	Female	1340	1638	18.2	500.0	1840	-12.3	100
Miraz	10	Male	1410	1890	25.4	500.0	1910	-1.1	100
Akash	10	Male	1310	1890	30.7	500.0	1810	4.2	95.8
Konika	10	Female	1030	1777	42.0	500.0	1530	13.9	86.1
Rbbi Miah	11	Male	1330	2038	34.7	500.0	1830	10.2	89.8
Md. Yakub	11	Male	1280	2038	37.2	500.0	1780	12.7	87.3
Md. Sakib Miah	11	Male	930	2038	54.4	500.0	1430	29.8	70.2
Md. Jaman	11	Male	1230	2038	39.6	500.0	1730	15.1	84.9
Kiran Miah	11	Male	1030	2038	49.5	500.0	1530	24.9	75.1
Farzana	11	Female	1210	1942	37.7	500.0	1710	11.9	88.1
Mithila	11	Female	930	1942	52.1	500.0	1430	26.4	73.6
Sharmin	11	Female	1230	1942	36.7	500.0	1730	10.9	89.1
Nishita	11	Female	1080	1942	44.4	500.0	1580	18.6	81.4
Choity Akter	11	Female	1130	1942	41.8	500.0	1630	16.1	83.9
Fatima Akter	12	Female	1180	2070	43.0	500.0	1680	18.8	81.2

Table 5: Impact study of EDRC on street children (age 4-12 yrs. for 14 boys and 18 girls

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Null Hypothesis	Male P value	Male Decision	Female P value	Female Decision
There is no mean difference between control and treatment group at day 0 of hemoglobin.	0.6331	Not rejected	0.7155	Not rejected
TWC	0.7534	Not rejected	0.7939	Not rejected
CRP	0.6779	Not rejected	0.6197	Not rejected
Prealbumin	0.899	Not rejected	0.6777	Not rejected
Independent t test at day 0 (α = 0.05).				

Table 6: Null hypothesis for selecting samples for control and treatment group at day 0.

Conclusion

A baseline survey on street children was conducted to generate awareness for malnutrition scenario in capital city of Bangladesh. Based on the Calorie gap estimated from baseline survey, low cost, nutritionally balanced and safe rice-based bakery food items were formulated for Bangladeshi population especially street children with malnutrition. Finally impact study on rice-based bakery items specially energy dense rice cake was found an effective supplementary diet for improvement of blood parameters in addressing malnutrition in street children. On the top of these research findings, rice-based food items seem have immense potential in Bangladesh, since these rice-based products usually utilize a relatively small amount of carbohydrate in preparation so it will help to reduce rice intake gradually. Rice based energy dense bakery products can also be utilized in school feeding nutritional program and disaster management related program in Bangladesh.

		Male		Female	
Null Hypothesis		P value	Decision	P value	Decision
The mean differences between the before and after treatment of Hemoglobin readings equals 0.		7.781e-05	Reject the null hypothesis	5.059e-07	Reject the null hypothesis
The mean of differences between the before and after treatment of CRP readings equals 0.		0.0260	Reject the null hypothesis	0.0007	Reject the null hypothesis
The mean of differences between the before and after treatment of Prealbumin readings equals 0.		5.34e-08	Reject the null hypothesis	1.497e-08	Reject the null hypothesis
The mean of differences between the before and after treatment of TWC readings equals 0.		0.0016	Reject the null hypothesis	0.0007	Reject the null hypothesis
Paired t test (α = 0.05).					

Table 7: Null hypothesis for the mean differences between the before and after treatment at day 120.

Null Hypothesis	Male P value	Male Decision	Female P value	Female Decision
There is no mean difference between control and treatment group at 120 days of Hemoglobin.	0.0004	Reject the null hypothesis	0.0307	Reject the null hypothesis
There is no mean difference between control and treatment group at 120 days of TWC.	0.0411	Reject the null hypothesis	0.0480	Reject the null hypothesis
There is no mean difference between control and treatment group at 120 days of CRP.	0.0078	Reject the null hypothesis	0.0003	Reject the null hypothesis
There is no mean difference between control and treatment group at 120 days of Prealbumin.	0.0419	Reject the null hypothesis	0.0410	Reject the null hypothesis
Independent t test at day 120 (α = 0.05).				

Table 8: Null hypothesis for measuring mean difference between for control and treatment group at day 120.

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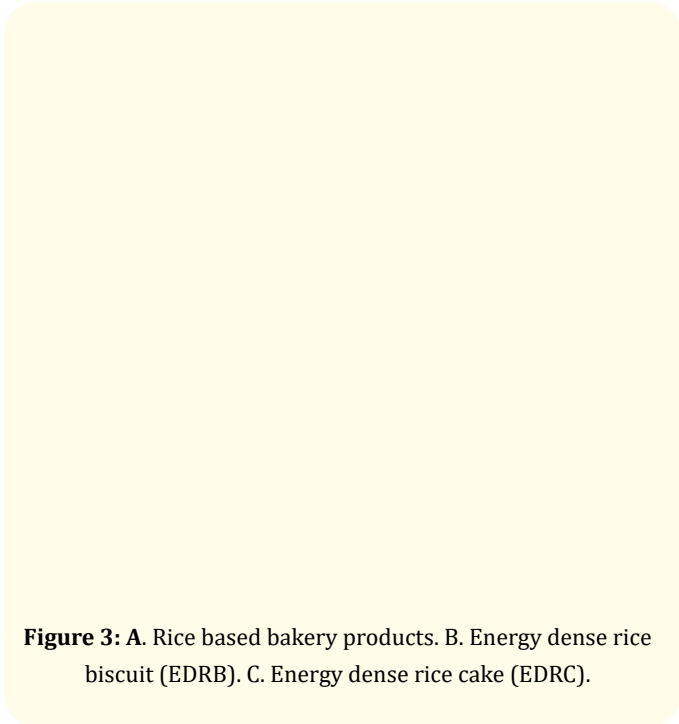
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Figure 3: A. Rice based bakery products. B. Energy dense rice biscuit (EDRB). C. Energy dense rice cake (EDRC).

Acknowledgements

Conflict of Interest

Authors declare that there is no any conflict of interest.

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