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A highly nutritive supplementary food:
Improving the nutritional status of pregnant and lactating mothers

KEYWORDS: Highly nutritive, supplementary food, pregnant and lactating mother, soy flour, carrot.

Abstract The nutrition situation of women is a considerable issue in Bangladesh. A highly nutritive supplementary food containing locally available food resource was prepared to meet the increased nutrient demands of pregnant and lactating mothers in Bangladesh. The supplementary food was developed mainly from wheat, soy flour, milk and carrot. The prepared food was analysed for the nutritional properties, protein efficiency ratio, microbiological quality and sensory attributes. All macro and micronutrients were within the ranges recommended by the Institute of Medicine and would fulfil the extra needs of the nutrients per day for pregnant and lactating mothers. The prepared supplementary food was observed satisfactory according to microbiological status, rat growth study and organoleptic evaluation. The developed ready-to- eat food could be served in the form of porridge with drinking water. The developed supplementary food was considerably more nutritious and cheap than the commercial supplementary foods available in Bangladesh and can help to reduce the level of maternal malnutrition.

INTRODUCTION

Pregnancy and breastfeeding are the most nutrient demanding periods of women's life. During pregnancy and lactation, the maternal nutritional status is not only important for the health of the mother but also closely linked to the well being of the child. A high proportion of low birth weight is an outcome largely attributed to maternal malnutrition. Malnutrition among women is widely prevalent in Bangladesh (1). Approximately 38% of young mothers aged 15-19 years suffer from malnutrition (Body Mass Index<18.5). The prevalence of iron deficiency anaemia and iodine deficiency among pregnant women is 40% and 56% respectively (2). It has reported in 2011 that the maternal mortality ratio of Bangladesh was 194 deaths per 100,000 live births (3). Malnutrition is a significant contributor to complicated pregnancies and high maternal mortality rate. Inadequate intake of food and poor diet are the primary causes of malnutrition (4). A study in rural Bangladesh has found that pregnant and lactating women consume only 1464 kcal/day during 5 to 7 months of pregnancy (5). This low energy intake meets only 53% of the daily energy requirement (2767kcal) of pregnant women (2nd trimester) having moderate activity. To combat malnutrition among mothers and children of low socioeconomic groups, Food and Agricultural Organization (FAO) has suggested developing supplementary foods based on locally available food grains (6). Nutritional supplementation during pregnancy has shown many benefits on both maternal and perinatal birth outcomes. Community-based trials on supplementation during pregnancy in multiple countries have shown that the micronutrient fortified foods, especially those containing milk and essential fatty acids, increased the mean birth weight by around 60–73 g (7). Another study has revealed that β-carotene supplementation with yellow-to-orange fruits and vegetables (carrots) improve the vitamin A and iron (Fe) status of lactating women (8). Sufficient intake of β-carotene rich fruits and vegetables is the most appropriate and sustainable solution to improve vitamin A status and prevent vitamin A related disorders in those people who are unable to meet Vitamin A requirements (9). Adequate nutrition is the key to a successful pregnancy for both mother and child. Food Intake should be sufficient during pregnancy and lactation period to maintain sound maternal health, proper foetus growth and successful lactation (10).Many developing countries are using supplementary foods prepared from cereals (wheat, Ragi, Bajra and sorghum), legumes (soy and Bengal gram), roots (carrots) and tubers to improve maternal nutritional status as well as aid in foetal development (6, 11).

At present there is no cereal-based supplementary food commercially available for pregnant and lactating mothers in Bangladesh. The usual diet of rural women in Bangladesh is monotonous and low in energy. They usually eat rice with green-leafy vegetables and sometimes a small amount of fish. Consumption of meat and other animal products is very occasional (5). Only a small sector of the community uses commercially imported supplementary food which is highly expensive. The aim of this study was to develop a ready-to-eat, highly nutritive supplementary food for pregnant and lactating mothers from locally available raw ingredients and technology to supply adequate nutrients to meet their daily requirements that can reduce the incidence of maternal malnutrition. The study also evaluated the nutrient composition, microbiological quality and organoleptic

characteristics of the formulated food and compared that to four imported supplementary foods available in Bangladesh.

METHODS AND MATERIALS

Materials

Wheat flour, soybean, sugar, skim milk powder and carrots were purchased from a local market in Dhaka city, Bangladesh. All the materials were stored at low temperature to ensure microbiological safety during the whole experimental period. For comparison purposes, four popular commercially available imported supplementary foods were purchased from the local market of Bangladesh and coded as f-1, f-2, f-3 and f-4. These commercial supplementary foods served as the control for assessing the nutrient levels of the formulated supplementary food. Then all supplementary foods were compared with the Recommended Dietary Allowances (RDA's) (12) to check whether these foods met the nutrient recommendations for pregnant and lactating mothers.

PROCESSING OF THE INGREDIENTS

Processing of Soybean

The healthy and mature soybean seeds were collected and weighted. The seeds were soaked overnight in 0.5% NaHCO3 solution (1:2.5 ratios) to inhibit the activity of all anti-nutritional factors. Then they were washed thoroughly, hulls removed and boiled for 30 minutes to remove the anti-nutrient factors. After that they were strained, dried in hot air oven at 80°C, ground into powder and sieved by a 100 mesh sieve.

Processing of carrots

Carrots were processed within 1-2 hours of collection to inactivate the enzymatic reaction. Good-orange-coloured carrots were taken from the market and washed properly to remove wastes. The peels of carrots were removed and grated properly. The grated carrots were blanched for 2 minutes at boiling temperature and cooled immediately. The carrots were then weighed and packed in poly bags. The bags were then refrigerated at 40°C temperature for further use.

Preparation of formulated supplementary foods

The developed supplementary food was prepared from wheat flour, milk powder, soybean flour and carrots in the ratio 20:25:20:5. All the dry ingredients and oil were mixed homogeneously. The wet ingredients (carrots and malt solution) were added to the mixture. Then a uniform semisolid mixture of raw ingredients was made by a mixture machine. The mixture was passed through a roller dryer and thin sheets of supplementary food were produced. The thin sheets of the product were dried at 65°c and then ground and mix with premix properly. Finally the prepared food was packed in sealed poly packs and stored for analysis. The flow diagram for the preparation of supplementary food is outlined below in Figure 1.

CHEMICAL ANALYSIS OF SAMPLES

Proximate analysis

The formulated supplementary food and the four imported commercial supplementary foods were analysed for proximate composition (moisture, crude protein, fat, ash and crude fibre) according to the standard methods of the Association of Official Analytical Chemists (AOAC) (13).

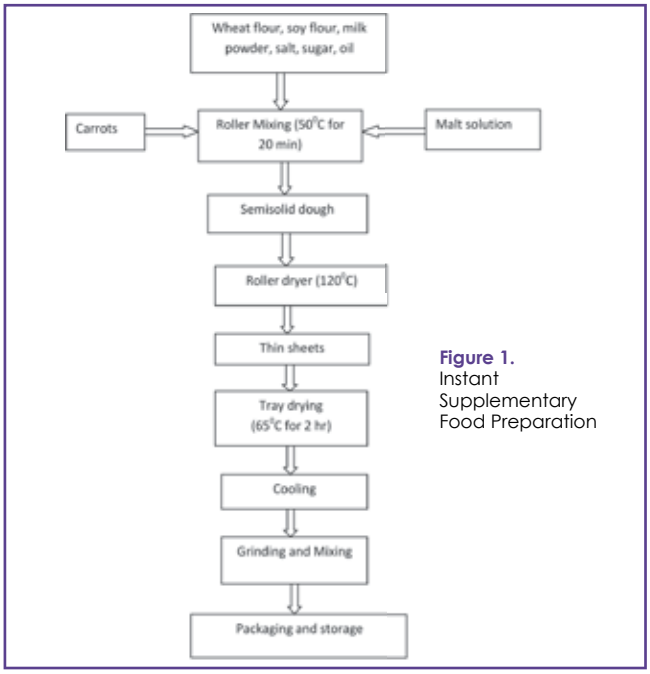

Figure 1. Instant Supplementary Food Preparation

Determination of microorganisms

Microbiological examination of the formulated supplementary food was performed to assess bacterial, fungal and yeast load under laboratory conditions. Standard Plate Count (SPC), Fungal and Yeast count and enumeration of Total Coliform and Salmonella of the food samples were examined according to the American Public Health Association (APHA) (14).

Rat growth study

To assess the nutritional quality of the formulated supplementary food and the commercial supplementary food, a standard rat growth study was done in the animal house section, Institute of Food Science and Technology (IFST), BCSIR, Dhaka. Long-Evan (28-30 day's old) rats were used to study the growth after feeding on the specific supplementary food. The rats were divided into four groups containing 4 female rats in each cage, maintained at room temperature with 12 hour light/dark cycle. They were subjected to a 7 days acclimatization period and the individual groups were given the same amount of commercial laboratory chow diet. After 7 days each rat group acclimatized on average 55g of different supplementary food and was fed water Ad libitum for 3 weeks. The control group was fed the casein diet containing 45% rice powder, 15% sugar and 10-11% protein prepared in our laboratory. Food consumption, spoilage and weight gain were recorded in every four days and then Protein Efficiency Ratio (PER) was determined according to V.Baskaran,et al (6).

PER= Weight gain of the test group (g) / total protein consumed (g).

Organoleptic evaluation

The food supplements were subjected to sensory evaluation by 10 trained members of the Institute of Food Science and Technology (IFST), (BCSIR), Bangladesh, using the hedonic scale method (15). Fresh supplements were assessed for their

colour, texture, flavour (aroma), taste and overall acceptability.

Statistical analysis

The mean and standard deviations of the triplicate analyses were calculated. The analysis of variance (ANOVA) was performed to determine significant differences between the means using Dunnett's T3 tests.

RESULTS AND DISCUSSION

Nutrient composition

The nutrient components of the supplementary food are presented in Table 1. It is clear from the result that the formulated supplementary food was nutritious, since the products provided required amount of all nutrients to meet the extra demand of pregnant and lactating mothers as per the RDA (12).

Nutrient	Formulated Food	f-1	f-2	f-3	f-4
Moisture (g/100g)	2.90 ± 0.10^{a}	2.02 ± 0.10^{b}	2.03 ± 0.22^{b}	1.16 ± 0.16^{a}	2.02 ± 0.15^{b}
Ash(g/100g)	3.17 ± 0.09^{a}	4.03 ± 0.40^{ab}	5.01 ± 0.12^{bc}	3.02 ± 0.18^{ab}	3.42 ± 0.54 ^{abc}
Protein (g/100g)	24.23 ± 0.08^{a}	18.46 ± 0.20^{b}	18.16 ± 0.15^{b}	20.89 ± 0.39^{a}	20.89 ± 0.42^{a}
Fat(g/100g)	9.37 ± 0.66^{a}	3.98 ± 0.14^{b}	16.75 ± 0.52^{c}	0.48 ± 0.07^{d}	0.48 ± 0.04^{d}
Fibre (g/100g)	0.20 ± 0.10^{a}	0.04 ± 0.01^{a}	0.03 ± 0.01^{a}	0.10 ± 0.02^{a}	0.10 ± 0.02^{a}
Sugar(g/100g)	16.02 ± 0.08^{a}	22.15 ± 0.32^{b}	19.44 ± 0.19^{c}	40.95 ± 0.69^{d}	39.47 ± 0.65^{d}
Carbohydrate (g/100g)	60.36 ± 0.44^{a}	71.77 ± 0.09^{b}	58.20 ± 0.67^{ac}	73.26 ± 1.79^{b}	73.57 ± 0.60^{b}
Energy (Kcal)	431.17±0.32^{a}	406.29 ± 0.45^{b}	464.62 ± 0.52^{c}	390.37 ± 0.30^{bd}	391.64 ± 0.54^{d}

Table 1. Comparison of Proximate Composition of Formulated and Commercial Supplementary Foods.

Mean values by different superscripts within columns are significantly different at ($p<0.05$).

The energy contents of the formulated and the commercial supplementary foods such as f-1 f-2, f-3, and f-4 were 431, and 406, 464, 390, 391 kcal/100g respectively. The energy content of the formulated supplementary foods was significantly ($p<0.05$) higher than the commercial supplementary foods. The extra recommended energy value for pregnant and lactating mothers is about 300 kcal and 550 kcal respectively (16). The formulated supplementary food provided 143.66% of the extra energy required of urban pregnant mothers having moderate activity (12). Additional protein is needed during pregnancy to cover the estimated 21 g/day deposited in foetal, placental and maternal tissues during the second and third trimesters (17). The protein content (g/100 g on dry basis) of the formulated supplementary food was 24.23g/100g whereas commercial supplementary foods f-1, f-2, f-3 and f-4 had 18.46, 18.16, 20.89 and 20.89 g/100g respectively. The protein content of the formulated supplementary food was significantly ($p<0.05$) higher than that of the commercial supplementary foods (f-1) and (f-2). According to the desirable dietary pattern for Bangladesh (12), the extra needs of protein are 14g and 19g during pregnancy and the first six months of lactation respectively. The formulated supplementary food could meet 173.07% and 127.53% of the extra needs of protein for pregnant and lactating mothers respectively. The fat content of the formulated supplementary food was 9.37g/100g which was significantly ($p<0.05$) higher than that of the commercial supplementary foods except for f-2.

The ash content of products represents the total amount of its minerals. The formulated food contained 3.17g/100g of ash which was almost similar to that of the commercial supplementary foods except for f-2 (5.01g/100g) (Table 1). Fibre is beneficial for maintaining good health. The formulated supplementary food contained 0.2g/100g of fibre that was closely similar to that of the commercial supplementary foods. The moisture content of the formulated food was 2.90 g/100g whereas the commercial supplementary food had the moisture content ranged from 1.16 to 2.03 g/100g. The results pertaining to proximate composition of prepared supplementary food were in conformity with the findings of V. Baskaran, *et al.* (6) who reported that energy and protein contents of eight supplementary foods developed for mothers and children based on soybeans and cereals were 340 to 398 kcal/100 g and 10.5 to 12.5% respectively.

Vitamins and Minerals content	Formulated supplementary food
Vitamin A (µg)	230.01 ± 0.11
Na (mg/100g)	156.43 ± 0.10
K (mg/100g)	116.55 ± 0.10
Fe (mg/100g)	12.5 ± 0.06
Ca(mg/100g)	400 ± 0.95
Mg (mg/100g)	33.39 ± 0.14
Zn (mg/100g)	5.0 ± 0.04

Table 2. Micronutrient Analysis of the Formulated Supplementary Food.

Mean ± Standard deviation

Micronutrient content of formulated supplementary food

Adequate intakes of micronutrients are necessary for pregnant and lactating mothers to prevent the specific micronutrient diseases and improve their immune response to infection.

The requirement for vitamin A and β-carotene is increased during the pregnancy and breastfeeding period. On average, intakes of Vitamin A and β-carotene should be one-third higher during pregnancy, and the breastfeeding period intake should be 0.7 mg/day higher than that for non-pregnant or non-breastfeeding women (17). Moreover, It has been reported that dietary supplementation with vitamin A or β-carotene reduce maternal mortality by 40% (17). The formulated supplementary food had the vitamin A content of 230.01µg/100g (Table 2). Iron enhances the body's immune system thus reducing infections and fostering the proper functioning of other organs of the body. Iron concentration of the formulated supplementary

food was 12.5mg/100 g (Table 2) which is quite higher than that of the milk-based product formulated for pregnant and lactating mothers in Africa (18). Calcium (Ca) is an essential micronutrient during pregnancy as it is associated with maternal bone mineralization, lower blood pressure, reduction of preterm deliveries and building bones and teeth of infants (19). The concentration of Ca was 400mg/100g in the formulated supplementary food and met 40% of the Recommended Nutrient Intakes (RNIs) (12). Potassium (K), sodium (Na) and magnesium (Mg) are electrolytes essential in the homeostatic balance of body fluids. The formulated supplementary food contained sodium, potassium, magnesium and zinc in amounts equal to 156.43, 116.55, 33.39 and 5.0mg/100 g respectively (Table 2). The results of the study of minerals were closely similar to the findings of Atton, et al (20). The developed supplementary food can be considered as a good source for iron, calcium and sodium. Egounlety & Syarief (21) reported that the addition of 25% soybean powder to supplementary food, Ogi (a fermented maize porridge), greatly improved the nutritive value of the food without affecting its acceptability.

Amino acid composition of the formulated supplementary food

The amino acid content of the formulated supplementary food is presented in Table 3. The formulated supplementary food had all the essential amino acid required for adult woman (22).

The formulated food had all essential amino acids to meet the requirement of pregnant and nursing mothers. The amino acid composition of the formulated food was comparable to that of WHO reference protein (22).

Amino Acids	Formulated supplementary food (g/100gm crude protein)	Amino acid Requirements (WHO-2007)[22] (g/100gm crude protein)
Aspartic acid	2.46 ± 0.01	
Threonine	0.88 ± 0.02	2.30
Serine	0.92 ± 0.03	
Glutamic acid	1.26 ± 0.01	
Glysine	1.18 ± 0.02	
Alanine	0.97 ± 0.02	
Valine	1.15 ± 0.03	3.90
Methionine	0.38 ± 0.03	1.60
Isoleucine	1.06 ± 0.02	3.00
Leucine	0.63 ± 0.03	5.90
Phenylalanine+Tyrosine	0.84 ± 0.02	3.08
Histidine	0.61 ± 0.02	1.50
Lysine	2.19 ± 0.02	2.20
Arginine	0.97 ± 0.02	

Table 3. Amino Acid Composition of the Formulated Supplementary Food.

Mean ± Standard deviation

Microbiological study of supplementary foods

Microbial analysis was conducted on the freshly formulated food sample to determine if the blend is wholesome for consumption. From the Table 4, it was found that the overall bacteriological status of the formulated and commercial supplementary foods was observed to be satisfactory.

Samples	Standard plate count (CFU/g)	Total Fungus (CFU/g)	Total Coliform count (CFU/g)	*Staphylococcus aureus* (CFU/g)
Formulated Food	<10	< 10	Nil	Nil
f-1	Nil	Nil	Nil	Nil
f-2	Nil	Nil	Nil	Nil
f-3	< 10	Nil	Nil	Nil
f-4	Nil	Nil	Nil	Nil

Table 4. Comparative Microbiological Study of Supplementary Foods.

The microbiological results of the formulated food indicated that the food was prepared with adequate thermal process, good quality raw materials and hygienic processing conditions. These results also suggested that the formulated and commercial supplementary foods are suitable to submit for sensory evaluation and rat growth study.

Organoleptic evaluation

Sensory analysis of the developed food is very important to determine consumer acceptance and improve the food quality (23). The scores for colour, texture, flavour (aroma), taste, and overall acceptability of the prepared food are shown in Figure 2. All the supplementary foods were accepted by the trained panelists. The colour and flavour of carrots made the formulated supplementary food product more acceptable than the commercial supplementary foods. Overall acceptability scores for the formulated and the commercial supplementary foods were almost similar as 7.77 and 7.76, 7.55, 7.35, 7.43 respectively. A study in Bangladesh has shown therapeutic benefit of peanut-based ready-to-eat food (Plumpy'nut) among malnourished pregnant and lactating women (PLW), while eight out of every 10 women receiving it found a problem related to its acceptability. It has been suggested to develop a ready-to-eat food alternative that has improved palatability and smell for adults and contained the adequate therapeutic effects for treating malnourished PLW in Bangladesh (24). The supplementary food prepared in the present study has been well accepted by the trained judges for its appearance and taste.

Rat growth study

From the result of rat growth study, the highest body weight gain was found (Table 5) in the rats fed on the locally prepared supplementary food; whereas, the body weight gain of rats fed on the commercial supplementary foods (f-1, f-2) and the control diet were almost similar.

Name	Sex	Food intake (gm)	Protein intake (gm)	Weight gained after 16 days (gm)	PER
	Female				
Control group	4	314.6	55.52	196	3.54
Prepared food	4	324.5	70.28	269	3.83
f-1	4	350.52	62.15	222	3.57
f-2	4	320.15	60.25	205	3.40
f-3	-	-	-	-	-
f-4	-	-	-	-	-

Table 5. Determination of PER of the supplementary foods.

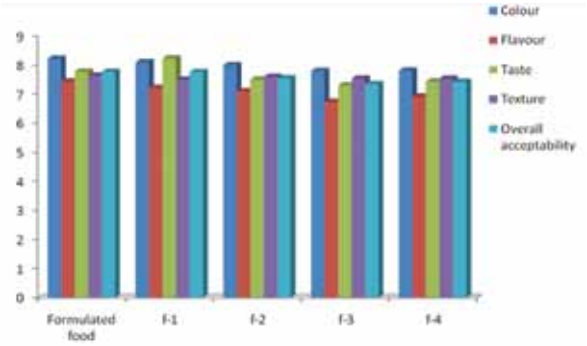

Figure 2. sensory evaluation of formulated and commercial supplementary foods.

Other two commercially imported supplementary foods f-3 and f-4 were not available in the local market at the time of rat growth study.

No side effects, such as diarrhoea or emesis, were observed in animals consuming the supplementary foods. This is in agreement with the results of other supplementary foods based on cereals, legumes and soy (6).

The formulated supplementary food had a slightly higher PER value than the commercial supplementary foods. Egounlety & Syarief (21) has reported that supplementary food contained corn and soy had significantly higher PER value than the supplementary food without soy. Faller *et al*. (25) reported that addition of soy protein improved the nutritional value of animal feed and extruded corn snacks. The results of the present study indicated that the supplementary food is adequate and suitable for pregnant mothers to gain required body weight.

CONCLUSIONS

The developed supplementary food based on wheat, soy and ß-carotene rich carrots were good in appearance and taste, which can make the food highly acceptable to mothers. The nutrient composition and biological (PER) evaluation of protein quality of the prepared supplementary food suggests that the food is nutritious and well accepted by rats. Further, the developed supplementary food was most satisfactory compared to the commercial supplementary foods in terms of vitamin and mineral content, microbial status and sensory evaluation. Thus, the formulated supplementary food met the food safety standards and ensured a rapid gain in weight. The supplementary food can be easily prepared on a small or large scale for mass feeding programs. Finally, this prepared supplementary food can help reduce incidence of maternal malnutrition by meeting the special needs of pregnant and lactating mothers in Bangladesh.

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REFERENCES

1. Tahmeed Ahmed, Mustafa Mahfuz, Santhia Ireen, et al. "Nutrition of children and women in Bangladesh: trends and directions for the future", Journal of health, population, and nutrition, 30 (1), 1-11 (2012).
2. Mitra and Associates, and ICF International. Nutrition of Children and Adults, Chapter 11, in Bangladesh Demographic and Health Survey 2011, National Institute of Population Research and Training (NIPORT), Dhaka, Bangladesh and Calverton, Maryland, USA (2013).
3. International Centre for Diarrhoeal Disease Research, Bangladesh: http://www.icddrb.org/media-centre/news(last checked on July.22$_{th}$ 2015).
4. United Nations Childrens fund, Bangladesh. Women and Girls in Bangladesh: http://www.unicef.org/bangaldesh (last checked on July. 22$_{th}$ 2015)
5. Ashraful I Khan, Iqbal Kabir, Eva-Charlotte Ekström, et al. "Effects of prenatal food and micronutrient supplementation on child growth from birth to 54 months of age: a randomized trial in Bangladesh", Nutrition Journal 10 (1),134 (2011).
6. V. Baskaran, Mahadevamma, N.G. Malleshi, et al. "Biological evaluation for protein quality of supplementary foods based on popped cereals and legumes suitable for feeding rural mothers and children in India", Plant Foods for Human Nutrition, 56 (1), 37–49 (2001).
7. Zhenyu Yang, Sandra L. Huffman. "Review of fortified food

and beverage products for pregnant and lactating women and their impact on nutritional status", Maternal and Child Nutrition, 7(3), 19–43 (2011).
8. Thokozile N. Ncube , Ted Greiner*, Lucie C. Malaba**, et al. "Supplementing Lactating Women with Puréed Papaya and Grated Carrots Improved Vitamin A Status in a Placebo-Controlled Trial", Journal of Nutrition,131(5),1497-1502 (2001).
9. Strobel M., Tinz J., Biesalski H. K. "The importance of β-carotene as a source of vitamin A with special regard to pregnant and breastfeeding women", European journal of nutrition, 46(9), 1-20 (2007).
10. Shahid, Asma Rumanaz, Asma Ul Hosna, Ashraful Alam. "Pregnancy and Nutrition", Bangladesh Journal of Medical Science,11 (4), 267-272 (2012).
11. Khan, Ashraful Islam, Iqbal Kabir, Eva-Charlotte Ekstrom, et al. "Effects of prenatal food and micronutrient supplementation on child growth from birth to 54 months of age: a randomized trial in Bangladesh", Nutrition Journal, 10(1) 134 (2011).
12. Faruque, Md Omar, Sayeda Saleha Saliheen Sultana, Muhammad Ali Siddiquee. "Desirable Dietary Pattern for Bangladesh", Final Research Results, 3, 227 (2013).
13. AOAC International. Official methods of analysis of AOAC International. AOAC International, (2005).
14. Downes, Frances Pouch, Keith Ito. "Compendium of methods for the microbiological examination of foods American Public Health Association", Washington, DC, 473-81 (2001).
15. Induja Awasthi, Pornoor Siraj, Maitrayee Tripathi et al "Development of Soy Fortified High Protein and High Calorie Supplementary Biscuits", Indian Journal of Science and Research, 3(1), 51-58(2012).
16. Institute of Medicine (IOM). DRI Dietary Reference Intakes for Energy, Carbohydrates, Fiber, Fat, Protein and Amino Acids (Macronutrients).National Academy Press Washington, DC. (2005).
17. Mary Frances Picciano. Pregnancy and Lactation: Physiological Adjustments, Nutritional Requirements and the Role of Dietary Supplements. The Journal of Nutrition,133 (6), 1997S-2002S (2003).
18. Ross S.M., Nel E., Naeye R.L. "Differing effects of low and high bulk maternal dietary supplements during pregnancy", Early Human Developmen,t 10, 295–302 (1985).
19. Chan, Gary M., Kathleen McElligott, Teresa McNaught, et al. "Effects of dietary calcium intervention on adolescent mothers and newborns: a randomized controlled trial", Obstetrics & Gynecology, 108 (3), 565-571 (2006).
20. Atton, Carol, Patsy JM Watney. "Selective supplementation in pregnancy: effect on birth weight", Journal of Human Nutrition and Dietetics, 3 (6) 381-392 (1990).
21. Egounlety M, Syarief. "Study on the supplementation of Ori with temp", Nigerian Food Journal10, 92–102, (1992).
22. Joint, W. H. O. "Protein and amino acid requirements in human nutrition." World health organization technical report series 935.1 (2007).
23. Singh-Ackbarali, Dimple, and Rohanie Maharaj. "Sensory Evaluation as a Tool in Determining Acceptability of Innovative Products Developed by Undergraduate Students in Food Science and Technology at The University of Trinidad and Tobago", Journal of Curriculum and Teaching, 3 (1),10 (2014).
24. Ali, Engy, Rony Zachariah, Zubair Shams, et al. "Peanut-based ready-to-use therapeutic food: how acceptable and tolerated is it among malnourished pregnant and lactating women in Bangladesh?." Maternal & child nutrition (2013).
25. Faller JY, Klein BP, Faller JF. "Acceptability of extruded corn snacks as affected by inclusion of soy protein", Journal of Food Science, 64 (1),185–188 (1999).