NUTRITIONAL COMPOSITION AND SENSORY ACCEPTABILITY OF WEANING FOOD FORMULATED FROM RICE GRUEL, NUT, CORN AND POWDER MILK.

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Roll No. : 0118/15

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A thesis submitted in the partial fulfillment of the requirements for the degree of Master of Science in Applied Human Nutrition and Dietetics

Department of Applied Food Science and nutrition

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This is to certify that we have examined the above Master's thesis and have found that is complete and satisfactory in all respects, and that all revisions required by the thesis examination committee have been made

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DECEMBER 2019

DEDICATED TO MY RESPECTED

AND BELOVED PARENTS AND TEACHER

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Table

Figures

Abbreviation	
%	percentage
^{0}C	Degree centigrade
G	Gram
Kcal	Kilo Calorie
Kg	Kilo gram
FAO	Food and Agriculture Organization
CHO	Carbohydrate
TVC	Total viable count
SAD	Sabouraud dextrose ager
mg	Mili gram
ANOVA	Analysis of variance
AOAC	Association of official Analytical Chemists
Ca	Calcium
Mg	Magnesium
Fe	Iron
Zn	Zinc

Abstract

The research study was conducted to develop a weaning food where rice gruel powder is the key ingredients and compare its nutritional facts with commercially available weaning food (Cerelac).This study, three types of rice gruel powder Betti (atop), Nurjahan (boiled), Balam (ayush) were used to develop a weaning food and nutritional composition of three rice gruel powder were ranged from moisture (7.69 - 10.17)%, ash (1.55-2.33)%, protein (3.33-3.68)%, fiber (11.33-18.81)%, carbohydrate (65.05-74.98)% and energy (283 -321) kcal/100g respectively. By using those three rice gruel powder for formulated weaning food where rice gruel powder ratio were different and other ingredients are same in amount. The proximate nutrients, mineral content, microbial and sensory qualities of the formulated diet were comparing with commercial weaning food (cerelac). Among three formulation, Protein content found high in sample A (10.85) % where commercial weaning food (cerelac) was found protein content D (10.01) %. Mg (310-320) %, Ca (330-660) %, Fe(4.87-5.72) %, Zn(8.27-9.02) % also found significantly higher than cerelac. In case of sensory evaluation showed that the formulated foods were less preferred than cerelac. Unlike the cerelac, the formulated diet did not have strong vanillin flavour and contributed to its lower sensory scores. The high amount of protein and energy content supplied by the formulated diet suggest that they can be used as the low cost weaning diet in opening planed to minimize protein energy malnutrition.

Key words: Weaning food, formulated diet, sensory evaluation, rice gruel powder

Chapter I: Introduction

Rice is one of the most important cereals in south east Asian countries. Commercially, there are more than 2000 varieties of rice grown throughout the world. It is the staple food of more than three billion people, mainly in Asia. But in Bangladesh rice gruel is used as the byproducts. Most of the nutrients and minerals are leached out from the rice through gruel during cooking.

Bangladesh is one of the twenty countries where 80% of the world's undernourished children live (Owais *et al*., 2015). Among nutritional disorder, malnutrition is the most common in developing countries and causes morbidity and mortality worldwide among the children (Musa *et al*., 2014). Due to the prevailing unfavorable economic conditions in most developing countries of the world, the incidence of protein-energy malnutrition among different age groups particularly children with an estimated 400million children being reported to be malnourished worldwide is highly prevalent and on the increase on a daily basis (Agiriga and Iwe, 2009).

Chronic malnutrition is penitent problem for young children .Attempts have been made to devise strategies for combating this nutritional problem by developing nutrition food of high protein and energy value based on cereal-legume combination. (Anigo *et al*., 2010) formatted complementary food from mated cereals, soya bean and groundnut, (Muhimbu *et al*., 2011) formulated complementary diets based on maize, sorghum and finger millet as stapes an common beans ,cowpeas and green peas as protein supplement. In developing countries commercial weaning foods are very expensive and out o low income families. This may pose a risk to the life of children as they may be susceptible to malnutrition. Weaning food is used of the time locally produced and based on cereals that are processed into porridges. Apart from their bulkiness reported as a probable factor in the etiology of malnutrition (WHO, 2001)

Weaning is the procedure of gradual implantation of the mother's milk with solid and semi semisolid foods in Childs diet in order to fulfill their growing needs. Formulation of weaning food rich in protein, carbohydrate and other nutrients (Codex, 2003).Calories and others nutrients are needed in children until the child is ready to

eat the family diet. Cereals which is used from the primary basis for weaning food but have low protein content and are bulky (Kikafunda *et al*, 1997).It may be possible to achieve an adequate protein energy intake for older children and adults by increasing the daily intake of cereals based foods, the quantity of the conventional diets required to meet energy needs are too widely for the infant to ingest. Tuber and roots offer the potential alternatives to cereals as weaning foods to reduce the incidence of malnutrition. They form a major staple food group in most development countries of Africa, Asia and America.

Milk is an excellent source of all nutrients except iron and ascorbate. Milk has been recognized as an important food for infants and growing children (Udeozor and Oluchi, 2012). Studies have shown that the consumption of milk is beneficial to the health of children and adolescents (Black *et al.,* 2002; Spence *et al.*, 2011).

Human milk is the ideal food for infants. It special composition fulfils the newborn's nutritional and physiological needs during the first 6 months of life. The weaning period is a crucial period in an infant's life. At the age of 5 to 6 months, most infants begin to eat supplementary semisolid foods. Infants food play a major roles in their nutrition in this stage (Martinez *et al*., 2004).The food and agricultural organization (FAO) reported that about 2.0 billion people globally are suffering from chronic malnutrition , which is manifested in diseases like kwashiorkor or, marasmus and other related nutritional problems. About 1.2 billion people of this country are from the developing countries of Asia, Africa and Latin America, where the most prevalent cause of death in infants after weaning is protein energy malnutrition. Protein energy malnutrition continues to be a major public health problem among children throughout the developing countries. Poverty and poor feeding practices are responsible for this nutritional problems that told Sachs and Mcrthur (2005). Childhood malnutrition caused by the consumption of weaning food of low nutrient density is common in developing countries (Black *et al*., 2008).

Commercial weaning foods are available but most of them are priced beyond the reach of the majority of the population in less developed country. These foods are sold in sophisticated packaging and using high technology. There is necessity for low cost weaning diets which can be made spontaneously and from locally available raw material. Therefore, the present study was undertaken to develop a cereal based

weaning food for young children of Bangladesh by using available resources and cheap technology.

1.3 Aim of the study:

The aim of this work is to formulate a low cost, nutrient rich and energy dense weaning food from mixtures of rice, corn, ground nut, and powder milk that are available in Bangladesh

1.2 Objectives of the Study:

- To formulated weaning food incorporating rice gruel powder
- To comparative nutritional value of formulated weaning food with commercial one
- To evaluated shelf life of formulated weaning food

Chapter II: Review of literature

All over the globe functional foods are gaining popularity in view of their inherent health benefits. Today consumers are more health conscious and very choosy in their food habits .The commercial weaning food manufactures have focused much on supplementing the balanced nutrients to various age groups of children. According to FAO (2002), plants and cereal grains provide nearly 70% of food proteins and more than 80% of food energy requirements

Weaning refers to introduction of solids to diet or introduction of food other than mother's milk. It is the process to include food and drinks other than beast milk or infant formula as it is the period of infant vulnerability (Sajilata *et al.,* 2002). In this period nutritional requirements for growth and brain development are high. Weaning period is the whole period during which breast milk is being replaced by other foods usually starts when infant is 4-6 months old and is expected up to the age of two three years. Protein energy malnutrition is an important nutritional deficiency condition that often occurs during the critical transitional phase of weaning infants crippling their physical and mental growth. This state can be preventing by introducing weaning foods of good quality at right proportion and at right stage **(**Pawar and Dhanvijay, 2007).

Dietary protein recommendations have traditionally been based on preventing deficiency (i.e., the RDA), as opposed to promoting optimal health, muscle development and maintenance and disease prevention. The RDA is defined as the amount of a particular nutrient that would satisfy the needs of almost all (98%) of the specified population. However, the RDA is not the requirement of an individual or even a mean for individuals, but rather the amount of the nutrient that is almost certain to be adequate for all individuals in a specified population. A significant percentage of adolescent and older females do not consume enough protein. The research report found the average percent of energy from protein ranged from 13.5 percent of calories in children 4-8 years old to 16 percent of calories in adults 51-70 years old. (Mcneill, 2008)

In most of the developing countries malnutrition is one of the major causes of morbidity and mortality among children.. Low cost infant supplementary foods have been developed and are being supplied to the needy through state sponsored nutrition intervention programmers (Milan *et al*., 2007). Human milk is the bet reference standard to which all infant formulae compare and has always been considered as a specific food. Modern infants formulae are being designed for infant, based on our knowledge of human milk (Mingruo, 2007).The weaning food mix should be nutritionally well-balanced in protein, fat, carbohydrate and minerals. It should be precooked, if possible, so that it can be fed to babies as a soft product by simply stirring in hot or warm water (Desikachar, 1992). The amount of nutrient requirement of a baby per g boy weight decline over the period of birth owing to decreasing growth rate, even through energy requirement for activity increases as the infant become older (Makhal *et al.,* 2003). A new born baby weight s on average 2.7 g at birth and will be about 5.4 kg at six months and 8 kg by one year (power and Dhanvijai,2007).

Yeasmin and Islam (2016) reported that nutritional deprivation is rampant in children of school age, particularly primary school age children ranging in magnitude from 20%-80%. Since deficient physical growth is naturally reflected in their suboptimal mental development. Malnutrition, which refers to an impairment of health either from a deficiency or excess or imbalance of nutrients, is the public health significance among children all over the world especially in developing countries. In one of the largest studies in anthropometric status of school age children in low income countries like Bangladesh found the overall prevalence of stunting and underweight to be high, ranging from 48% to 56% for stunting and 34-62% for under weight. It is therefore evident that a significant percentage of school age children suffering from malnutrition, which affecting their health, nutritional status and school academic performance

Hoque *et al*., (2016) reported that malnutrition is the most common nutritional disorder in developing countries and it remains one of the most common causes of morbidity and mortality among children worldwide. Nearly half of all deaths in children under 5 are attributable to under nutrition. Under nutrition puts children at greater risk of dying from common infections, increases the frequency and severity of

such infections and contributes to delayed recovery. In addition, the interaction between under nutrition and infection can create a potentially lethal cycle of worsening illness and deteriorating nutritional status. Poor nutrition in the first 1,000 days of a child's life can also lead to stunted growth, which is irreversible and associated with impaired cognitive ability and reduced school and work performance. Good nutrition is the cornerstone for survival, health and development. Malnutrition is the underlying contributing factor in about 45% of all child deaths, making children more vulnerable to severe diseases. 5.9 million Children under the age of 5 died in 2015. Child malnutrition causes 27.9% of child deaths in developing countries in 2015. The three main indicators used to define under nutrition, are underweight, stunting and wasting, represent different histories of nutritional status to the child. That occurring primarily in the first 2–3 years of life in children. Linear growth retardation (stunting) is frequently associated with repeated exposure to adverse economic conditions, poor sanitation, and the interactive effects of poor energy and nutrient intakes and infection

In the formulation of weaning food are used different ingredients from different sources to meet the requirements of the nutrients. Milk is a biological fluid; it contains essential nutrients for the growth and development of infants. However, bovine milk based dried formulations have become a prominent feature of weaning food dietetics (Thompkinson and kharb, 2007). A high proportion of the nursing mothers used local ingredients to formulate weaning foods for their babies. The nutritional composition of thee foods are of high quality, particularly for infants of low income parents who are unable to access commercial weaning foods (Ijarotimi and ogunsemore, 2007). Attempts have been made to utilize the ingredients like rice gruel powder, corn ,groundnut ,powder milk in weaning food formulation.

Gernah *et al*., (2011) reported that one of the most effective and convenient ways for improvement of nutritional value of cereals is malting and interest is growing in the formulation of food products using the combination of composite blends of malted cereals and legumes as a way of improving nutritional quality of the product suitable for children (Agu and Aluya,2004).

Over the past few decades Functional foods have a tropic of growing ponderosas for the food industry. Many consumers are inclining to pay for products those commitment beneficial effects (Suresh, 2013). Cereal based functional products could be ready by using cereals as subtracts for probiotics and yielding functionality (Charalampopoulos *et al*., 2002). Probioties are important functional foods and they constitute approximately 65 per cent of the world functional food market. They cn defend against infections, alleviate lactose intolerance, reduce blood cholesterol levels and inspiring the immune system (Renu *et al.,* 2005).The associated beneficial health effects of probioties could search for prevention and treatment of different diseases (Alvarez and Oberhelman 2001). Whey is deliberated as a way for health in light of the benefits that are imparted by whey proteins. Normal bovine milk includes 3.5 percent of protein of which casein constitutes 80 per cent and whey proteins 20 per cent. Liquid whey includes approximately 20 per cent of the original protein (Mrshal,1982). Today food industries are looking for ingredients which can provides good functional and nutritional feature for formulation of value added food products. Whey proteins provide good functional and nutritional feature for formulation novel products which have potential to raise the property of food products. There are main two groups of the most functional properties such as hydration related and surface related (Persaand and Barranco, 2004) .Hydration related functional properties contain dispersability, solubility, swelling, viscosity and gelatin. Surface related properties contain emulsification, foaming and absorption at air water interfaces (Rathore ,2009).

Shelf life is the extent of time that merchandise such as food may be placed without becoming unsuitable for use or consumption. It is the recommended highest time for which products can be paced during which the defined property of a specified proportion of the commodities remains receivable under expected situations of distribution, storage and indication (Gyesley, 1991). A food product within its shelf life should be secure to eat, keep its appearance, colour, texture and flavour and meet any nutritional demand provided on the label. All foods worse with time but the rate vary from food to food. Food quality affect different factors include microbial (bacteria, yeast and mold) growth, non-microbial spoilage (rancidity, browning and loss of nutrients) and product related spoilage such as water activity, pH and oxygen availability (Fontana, 2008; Sivasankar, 2010). Microbial load of a food is ascertained

by the elevation of microorganisms (measured in colony forming units per gram) in the food during production, packaging, storage and other handing as well as the type of food in question. The end of shelf life can be based on the quantity of microorganism present.

Parvin *et al.,* (2014) also assimilated the weaning baby food made in the laboratory with the commercial foods availble in Bangladesh. 74.39g/100g carbohydrates was found in the formulated food and 67.75 g/100g and 71.7g/100g carbohydrate was presented in the commercial foods such as cerelac 1 and cerelac 2.So the high amount of carbohydrate was found in the formulated diet. The protein content of the formulated diet was 11.91 g/199g whereas the the commercial diets were 15g/100g and 10g/100/g. the ash content was found in the formulated diet was 1.88 g/100g n the commercial diet cerealc 1 and cerelac 2 were2.45g /100g and 3.3g/100g respectively. The energy content in formulated diet was 433.9k cal/100g and the commercial diet were 421cal/100g and 418 kcal/100g respectively. The RDA of energy for Childs is 880 kcal/day, in this study for formulated baby food was slightly than commercial weaning foods and provides 8.28 % calories of RDA to meet the energy needs of the infant.

The preparation of weaning foods is very simple and can be processed easily. Such as different process unit are cooking, drying, blending and mixing can be prepared .It develop a new era and becomes an important nutrients rich food for children

Chapter III: Materials and Methods

The experiment was conducted in the laboratory of Applied Food Science and Nutrition, Food Processing and Engineering department, Biochemistry department, and poultry research and training center of Chattogram Veterinary and Animal Sciences (CVASU), Chattagram, Bangladesh during June to November, 2019 to manufacture quality of weaning food and also to determine nutrient content of it. Rice gruel powder such as Nurahan (boiled,) Betti (atop), Balam (ayush), corn, powder milk, suger, nut, cabinet dryer , saucepan were used in the experiment.

3.1 Experimental design

Firstly, Riyazuddin bazer in Chattogram was selected from where in three types of rice samples were collected. After collection of samples it was used for preparation of rice gruel from raw rice. Then rice gruel was used for preparation of powder. This powder was used to determine proximate composition (Moisture, crude protein, fat, ash, crude fiber and carbohydrate) and mineral (calcium,, magnesium, Zink, iron) contents for each three sample . This powder was then used formulation of weaning food. After processing of weaning food it was used to determine proximate composition (Moisture, crude protein, fat, ash, crude fiber and carbohydrate) and mineral (calcium,, magnesium, Zink, iron) contents . Consumers acceptability test for each products category (A=Formulation 1, B= Formulation 2, C=Formulation 3) were conducted. Similar analysis was done for one commercial brand category D of weaning foods.

3.2 Sample collection

5 kg Nurjahan rice (boiled), 5 kg Betti rice (atop) and 5 kg Balam rice (ayush) were collected from Riyazuddin bazer in Chattogram , Bangladesh.

3.3 Preparation of rice gruel powder from raw rice

At first 500g sample was weighted and washed with water to eliminated visible dirt then added 1700 ml water and coked 650 ^{0}c for 30 min. Then the gruel was separated from rice. The gruel was then placed in the cabinet dryer. After three days the cabinet dried sample was ground and sieved. Then found gruel powder. This processed was done the other two samples.

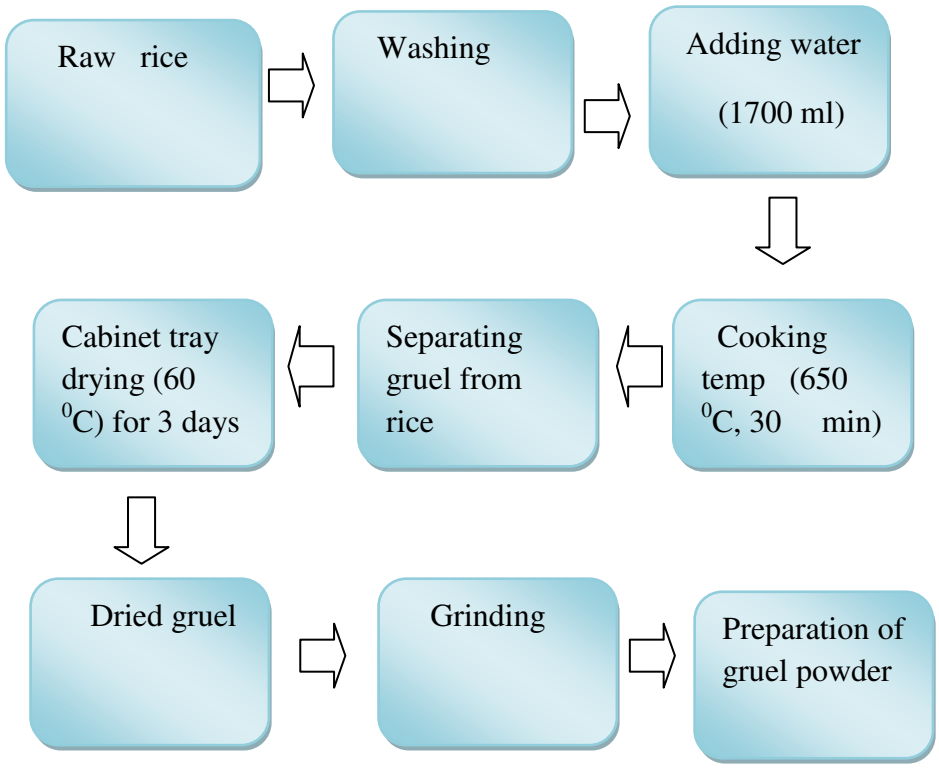

Figure 3.1: Preparation **of rice gruel powder**

3.4. Formulation of weaning foods

Three formulations were carried out to standardize the product. Based on the subjective evaluation, the trail that scored the maximum for all the sensory attributes and overall acceptability was selected as the best standard sample.

Table3.1 Formulation of weaning food

Ingredients	Formulation 1	Formulation 2	Formulation 3
Nurjahan rice gruel	17%	23.5%	17%
Betti rice gruel	10%	10%	23.5%
Balam rice gruel	23.5%	17%	10%
Powder milk	23.5%	23.5%	23.5%
Suger	10%	10%	10%
Corn	6%	6%	6%
Nut	10%	10%	10%
Total	100%	100%	100%

3.5. Processing of weaning food

All the ingredients were weighted according to the quantities given in table 3.2. Nurjahan rice gruel, betti rice gruel, balam rice gruel, powder milk, suger. Corn, and nut were added and mixing. The above mixture was grinded for uniform distribution of particles. Guthrie The prepared weaning food was carried for sensory evaluation and nutritive value.

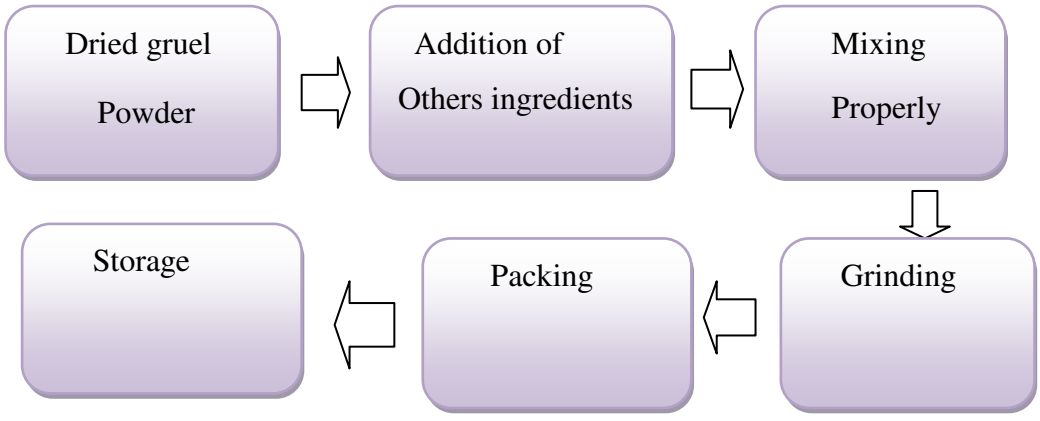

Figure3.2: processing of weaning food

3.6 Proximate analysis of weaning food

By using AOAC (2005) methods there were determined Moisture, Protein, Fat, Ash and Fiber of weaning foods and rice gruel powder. By using oven drying the moisture content was measured by heating at 105^{o}C to constant weight under normal atmospheric pressure. By using the Kjeldahl procedure (6.25×N) the crude protein content was measured (AOAC, 2005). By using the Soxhlet apparatus total lipid was extracted (AOAC, 2005). Ash was measured gravimetrically in a muffle furnace by heating at 550^{0} C to constant weight (AOAC, 2005).Crude fiber was determined by using AOAC method (2005).

3.6.1 Determination of moisture content

Principle: Moisture is normally present in food staff. At first the empty crucibles were weight and dried. Then 5 gm was placed on it. Then the crucible was placed in an air oven (thermostatically controlled) and dried at temperature of 105 ^{0}C for 24 hrs. After drying, the crucible was removed from the oven and cooled in desiccators. It was then weighed with cover glass. The crucible was again placed in the oven, dried for 30 minutes, took out of the dryer, cooled in desiccators and weighed. Drying, cooling and weighing were repeated until the two consecutive weights were same.

Apparatus: Crucible, hot air oven .desiccators, weighting balance

Calculation: The percentage of moisture was calculated as follow

$$\% \text{ Moisture} = \frac{\text{Initial weight} - \text{Final weight}}{\text{Sample weight}} \times 100$$

3.6.2 Protein determination

Principle: The kjeldhal method was used to estimation of nitrogen. The protein content of food stuff is obtained multiplying the nitrogen factor by 6.25. It is assumed that plant protein contents average 16% nitrogen. The factor for plant protein is 100/16=6.25%. The percent nitrogen is determined and crude protein by multiplying the factor 6.25.

Apparatus: Kjeldahl flask, Condenser, kjeldahl digestion unit.

Reagent required **:**

Concentrated H2SO4, Digestion mixture (Potassium sulphate 100gm + Copper sulphate 10gm + Selenium dioxide 2.5gm), Boric acid solution, Alkali solution, Mixed indicator solution, Standard HCl (0.1N) .

Calculation: Percentage of nitrogen and protein calculated by the following equation:

$$\text{Protein\%} = \frac{\text{Titration value} \times \text{Normality of HCl (0.1)} \times 0.014}{\text{Sample weight}} \times 6.25 \times 100$$

3.6.3 Crude Fat determination

Principle: Fat is calculated by dissolving food sample into qualitative solvents. Setting the filtrate into separating funnels and then separated mixture is the dried to count the extracted and the percentage of fat is calculated..

Apparatus: Soxhet apparatus, Thimble

Calculation: The percentage of crude fat calculated by the following equation

$$\text{\% Fat} = \frac{\text{Weight of extract}}{\text{Weight of sample}} \times 100$$

3.6.4 Determination of Ash content

Principle: The ash fracture contains all the mineral elements mixed together. This method performs oxidation of all organic matter by burning and measure the weight of remaining ash. Briefly, five grams (5 g) of sample was burned and put into muffle furnace with crucible at 550ºC for 8 hrs.

Apparatus: Porcelain, gas burner, muffle furnace.

Calculation: It was calculated using the following formula:

$$\% \text{ Ash content} = \frac{\text{The amount of ash in the supplied sample}}{\text{Sample weight}} \times 100$$

3.6.5 Crude fiber determination

Crude fiber was determined according to AOAC method (2005).

Principle: Crude fiber is the water insoluble fracture of carbohydrate consists mainly of cellulose, hemicelluloses and lignin. It is calculated through digestion of fat free known amount of food sample by boiling it in a weak solution of acid (1.25% H_2SO_4) for 30 minutes followed by boiling in weak solution of alkali (1.25% NaOH) for 30 minutes at constant volume and then deducting ash from the residue obtained.

Apparatus: Liebig condenser, Reflux condenser, Gooch crucible

Reagent required:

1. 0.255N Sulphuric acid solution
2. 10.0% Potassium sulphate solution;
3. Asbestos- Gooch grade.

Calculation: The loss in weight represents crude fiber

$$\text{Crude fiber } \% = \frac{\text{Weight of residue with crucible - weight of ash with crucible}}{\text{Weight of sample (moisture and fat free)}} \times 100$$

3.6.6 Determination of total carbohydrates

The carbohydrate content was determined by counting the difference of nitrogen free extractive. It was given as the difference between 100 and a sum total of the other proximate
ingredients. Hence it was calculated using the formula below:

% CHO = 100% - % (Protein + Fat + Fiber + Ash + Moisture content).

3.6.7 Determination of energy value :

The energy value of the samples was determined by multiplying the protein content by 4, carbohydrate content by 4 and fat content by 9 according to standard James formula (James, 1995).

Energy Value = (Crude protein × 4) + (Total carbohydrate × 4) + (Crude fat × 9)

3.7 Mineral analysis

Biochemical analyzer (Humalyzer 3000) is used to determine minerals' contents. Commercially available biochemical kit (Randox®) was used for biochemical assay.

3.7.1 Sample preparation

At first 1 g rice gruel powder were weighed into digestion vessel. Then added HNO_3 and H_2O_2 at the ratio (2:1). Then heat the vessel with 400 watts until the samples were dried 4/3 parts. It was filtered on a filter paper & taken the filtrate to a volumetric flask (as 100 ml) and made up to the mark which was used for mineral contents determination. The procedures of sample preparation of rice gruel powder were followed for the preparation of weaning foods.

3.7.2 Determination of Calcium (Ca)

Principle: Calcium ions form a violet complex with O-Cresol phthalein complex one in an alkaline medium.
Colorimetric method: O-Cresol phthalein complex one, without de proteinization..

Assay:

Wavelenght/filter : Hg 578 nm (550-590)

Spectrophotometer: 570 nm

Temperature : 20-25 ^{o}C/37^{o}C

Light path : 1 cm

Calculations

$$\text{Concentration in ca mg/dl} = \frac{(A)\,\text{Sample}}{(A)\,\text{Standard}} \times \text{Standard conc(mg/dl)}$$

3.7.3Determination of Magnesium

Principle: The method is based on the specific binding of calmagite, a metallochromic

indicator and magnesium at alkaline Ph with the resulting shift in the absorption wavelength of the complex. The intensity of the chromophore formed is proportional to the concentration of magnesium in the sample.

Assay:

Wavelength/fitter: 520 nm, Hg 546 nm 500-550 nm (Increase of absorbance)

628 nm, Hg623nm 570-650 nm (Decrease of absorbance)

Temperature : 20-25^{o}C/37^{o}C

Light path: 1 cm

Measurement: Against reagent black

Calculation

$$\text{Magnesium (mg/dl)} = \frac{(A)\,\text{Sample}}{(A)\text{Standard}} \times \text{Standard conc (mg/dl)}$$

3.7.4 Determination of Iron (Fe)

Principle: The iron is dissociated from transferring-iron complex in weakly acid medium. Liberated iron is reduced into the bivalent form by means of ascorbic acid. Ferrous ions give with Ferrozine a colored complex. The intensity of the color formed is proportional to the iron concentration in the sample.

Assay:

Wavelength/ filter: 562nm

Tempeture: 37^0C/15-25^0C

Light path 1 cm

Calculation:

$$\text{Iron in (µg/dl)} = \frac{\text{(A) Sample-(A) Sample blank}}{\text{(A) Standard}} \times \text{Standard conc (mg/dl)}$$

3.7.5 Determination of zinc

Principle: Zinc is an alkaline medium reacts with Nitro-PAPS to from a purple colored complex. Intensity of the complex formed is directly proportional to the amount of zink present in the sample.

Assay

Wavelenght/filter: 570 nm

Temperture: R.T

Light path: 1 cm

Calculation

$$\text{Zinc in (µg/dl)} = \frac{\text{Absorbance of test sample}}{\text{Absorbance of standard sample}} \times \text{Standard conc (mg/dl)}$$

3.6 Bacteriological investigations of the weaning foods

The bacteriological investigation of the weaning foods was done in Poultry Research and Training Centre (PRTC), Chattogram Veterinary and Animal Sciences University, to get an idea about the shelf life of the products.

3.6.1 Required apparatus:

Balance, Conical flask, Autoclave machine, Test tube, Durham's tube, Pipette, Rack, Micropipette, Water bath, Incubator, Hot air oven

Reagents: Plate Count Agar, Saborauded Dextrose Agar **,** MacConkey broth

3.6.2 Isolation of total viable count

A total viable count was done according to (FAO, 1997) using plate count agar (Oxoid, CM 0325). One ml of weaning food sample was homogenized using vortex mixer (VM-300, Taiwan) with 9 ml sterile peptone water to obtain first dilution. One ml of the sample from a selected dilution was pour-plated in duplicate and incubated for 24 hours at 37°C. The enumeration of bacteria was performed using digital colony counter and the result was expressed as colony forming units per ml (CFU/ml).

3.6.3 Isolation of total coliform count

Total coliform count was done according to Standard Methods. The media was prepared according to manufactures instructions. At first 10ml macConkey broth distributed in every test tube (9 test tubes), where durhan's tube placed inverted position. Then autoclaved at 121℃ for 15 minutes and incubated at 37℃ overnight for contamination check .After checking, then added 10:1:0.1ml ratio sample into test tube and incubated at 37℃ 24hours.when color was changed and gas produced coliform positive either negative.

3.6.4 Isolation of yeast

Yeast was carried out according to FAO (1997). Saborauad Dextrose Agar (Hi media, M096) media was prepared according to manufactured. Then poured into Petridis and incubated overnight for checking contamination. One ml of homogenized sample was taken and plated on prepared SDA media in duplicate. The result was expressed as yeast growth was present or not.

3.7 Sensory Evaluation

20 gram of three formulation and commercial complementary food were mixed individually with 70 ml of boiled water. The suspension was mixed up with a spoon for 2 minutes at room temperature. Prepared weaning foods A,B,C and Cerelac were subjected to sensory evolution by 30 panelists. In case of sample B, there was added cinnamon and venillin flavor. Panelists were requested to express their feeling about the products by counting the following attributes appearance, aroma, taste , consistency and overall acceptability. Sensory scores were based on a nine point hedonic scale .The scale were arranged such that Like extremely = 9, Like very much = 8, Like moderately = 7, Like slightly = 6, Neither like nor dislike = 5, Dislike slight = 4, Dislike moderately = 3, Dislike very much = 2, Dislike Extremely = 1. All analyses were carried out in duplicate for each sample and results obtained were computed means. The data was analyzed for one way ANOVA procedures under computerized statistical methods to compare the means.

3.8 Statistical analysis

Statistical analysis data (nutritional composition, minerals content, and sensory evaluation) were determined and stored in Microsoft Excel 2007 spread sheet to evaluate statistical analysis. All samples were in three replicates. Descriptive statistics (mean, standard deviation) were done for proximate composition, mineral contents of all samples, and sensory evaluation of rice gruels powder and weaning foods . Data were sorted, coded and recorded in IBM SPSS Statistics 25. After that statistical analysis were conducted. Nutritional composition, mineral content and sensory evaluation data were analyzed by using One way ANOVA procedures to assess significant level of variation at 95% confidence interval. Post hoc “Tukey” test was conducted to identify the variation within the sample groups. The statistical analysis was conducted for at 5% level of significant $(P < 0.05)$.

Chapter IV: Results

4.1 Nutritional composition of rice gruels

Table 4.1 showed (ME±SD) of nutritional composition of rice gruels, where A,B,C are represented Betti rice gruel powder, Nurjahan rice gruel powder and Balam rice gruel powder respectively. Moisture, Fat, Ash, Fiber, CHO content are the significantly different among the sample. But Protein content sample B and C are not significantly different. Carbohydrate content was highest (74.98±0.01) % in sample A and lowest value (65.05±0.01) % was found in sample B. In case of energy Sample C had highest value 321.72 kcal/100g and the lowest value 283 kcal/100g was scored by Sample B.

Table 4.1 Nutritional composition of rice gruels

Sample	Moisture (%)	Ash (%)	Protein (%)	Fat (%)	Fiber (%)	CHO (%)	Energy(Kcal)
A	7.69±0.01[a]	1.55±0.01[a]	3.33±0.01[a]	ND	12.45±0.01[b]	74.98±0.01[c]	321
B	10.17±0.01[c]	2.02±0.01[b]	3.67±0.01[b]	.22±0.01	18.81±0.01[c]	65.05±0.01[a]	283
C	7.98±0.01[b]	2.33±0.01[c]	3.67±0.01[b]	ND	11.33±0.01[a]	74.67±0.01[b]	321

Values are means ± standard deviations of triplicate determination. Values in the same column having the same super script letters are not significantly difference (p <0.05) , Values in the same column having the differ super script letters are differ significantly (p <0.05), ND= Not detected

4.2 Nutritional composition of weaning food

Table 4.2 showed (ME±SD) of nutritional composition of three formulated weaning foods, where A,B,C,D represented Formulation 1 (Nurjahan rice gruel powder =17%, Betti rice gruel powder =10%, Balam rice gruel powder =23.5%),Formulation 2((Nurjahan rice gruel powder =23.5%, Betti rice gruel powder =10%, Balam rice gruel powder =17%), Formulation 3((Nurjahan rice gruel powder =17%, Betti rice gruel powder =23.5%, Balam rice gruel powder =10%) and one commercial brand Cerelac. Moisture, Ash, Protein, Fat, Fiber, Carbohydrate are significantly different among the sample. The protein content was found highest in sample A (10.85±0.01) % and lowest in sampled D (10.01±0.01) %. Carbohydrate content was highest (68.25±0.01) % in sample D and lowest (60.24±0.01) % in sample B.

Table 4.2 Nutritional composition of weaning food

Sample	Moisture (%)	Ash (%)	Protein (%)	Fat (%)	Fiber (%)	CHO (%)	Energy(Kcal)
A	7.42±0.01^{b}	2.67±0.01^{c}	10.85±0.01^{d}	11.45±0.01^{d}	6.72±0.01^{c}	60.87±0.01^{c}	390
B	7.82±0.01^{c}	2.62±0.01^{b}	10.76±0.01^{c}	11.17±0.01^{b}	7.37±0.01^{d}	60.24±0.01^{a}	385
C	8.08±0.01^{d}	2.80±0.01^{d}	10.67±0.01^{b}	11.36±0.01^{c}	6.64±0.01^{b}	60.42±0.01^{b}	387
D	6.47±0.01^{a}	1.56±0.01^{a}	10.01±0.01^{a}	10.01±0.01^{a}	4.56±0.01^{a}	68.25±0.01^{d}	403

Values are means ± standard deviations of triplicate determination. Values in the same column having the different super script letters are significantly difference(p <0.05)

4.3 Mineral contents of rice gruel

Table 4.3 showed the mineral contents of rice gruel,where A, B, C are represented Balam rice gruel powder, Betti rice gruel powder and Nurjahan rice gruel powder respectively. Calcium, Magnesium, Iron and Zinc were significantly different among the sample. Magnesium and calcium higher in sample A and lower in sample C. The height value of Iron was found in sample A and lowest value was found in sample B. Zinc was found higher in sample A and lower value was found in sample C.

Table4.3 Mineral contents of rice gruel

Sample	Mg(mg/100g)	Ca(mg/100g)	Fe(mg/100g)	Zn(mg/100g)
A	110.33 ± 0.58^{c}	370.33 ± 0.58^{c}	12.56 ± 0.01^{c}	9.96 ± 0.01^{c}
B	60 ± 0.58^{b}	184.33 ± 0.58^{b}	8.41 ± 0.01^{a}	9.21 ± 0.01^{b}
C	30 ± 0.58^{a}	164.33 ± 0.58^{a}	9.87 ± 0.01^{b}	8.77 ± 0.01^{a}

Values are means ± standard deviations of triplicate determination. Values in the same column having the different super script letters are significantly difference (p <0.05)

4.4 Mineral contents of weaning food

Table 4.4 showed the mineral contents of rice weaning foods, where A,B,C,D represented Formulation 1 (Nurjahan rice gruel powder =17%, Betti rice gruel powder =10%, Balam rice gruel powder =23.5%),Formulation 2((Nurjahan rice gruel powder =23.5%, Betti rice gruel powder =10%, Balam rice gruel powder =17%), Formulation 3((Nurjahan rice gruel powder =17%, Betti rice gruel powder =23.5%, Balam rice gruel powder =10%) and one commercial brand Cerelac.

The height value of Magnesium (310.33±0.58) mg/100g was found in Sample A and lowest value(180.33±0.58) mg/100g was found in sample B. Calcium was found higher(660.33±0.58)mg/100g in sample B and lower (330.33±0.58) mg/100g in sample A. The height value of Iron (5.72±0.01) mg/100g was found in sample C and lowest value (4.01±0.01) mg/100g was found in sample D. Zinc was found higher (9.02±0.01)mg/100g in sample A and lower value (6.26±0.01)mg/100g was found in sample D.

Table 4.4 Mineral contents of weaning food

Sample	Mg(mg/100g)	Ca(mg/100g)	Fe(mg/100g)	Zn(mg/100g)
A	310.33 ± 0.58^{c}	330.33 ± 0.58^{a}	4.87 ± 0.01^{b}	9.02 ± 0.01^{c}
B	180.33 ± 0.58^{a}	660.33 ± 0.58^{d}	5.10 ± 0.01^{c}	8.27 ± 0.01^{b}
C	320 ± 0.58^{d}	560.33 ± 0.58^{b}	5.72 ± 0.01^{d}	8.27 ± 0.01^{b}
D	300.33 ± 0.58^{b}	610.33 ± 0.58^{c}	4.01 ± 0.01^{a}	6.26 ± 0.01^{a}

Values are means ± standard deviations of triplicate determination. Values in the same column having the same super script letters are not significantly difference ($p < 0.05$) , Values in the same column having the differ super script letters are differ significantly ($p < 0.05$),

4.5 Microbiological load of weaning food

Microbiological characteristics are strikes of safety quality and shelf life of prepared weaning food .Total viable count, Coliform, yeast count of the weaning foods were determined at one month. Result obtained are shown in table

Table 4.5: Microbiology quality of weaning foods

	One month		
Sample	TVC	Yeast	Coliform
A	3.5×10^2	ND	ND
B	2.4×10^2	ND	ND
C	2.0×10^3	ND	ND
D	2.2×10^2	ND	ND

Table 4.5 revealed that data regarding total viable count, total coliform and yeast in weaning foods sample A, B, C, D. Each sample was enumerated at 30 days of storage after processing of weaning foods. In all cases, total viable was detected and total coliform, and yeast were not detected..

4.6 Sensory evaluation of weaning food

Figure 4.2 showed that appearance were recorded (7.80± 0.76) in sample D and lower scored were recorded (6.07±0.90) in sample C. The highest score of color were recorded (7.77±0.77) in sample D and lowest scores were recorded (6.10±0.85) in sample C. Sample D (7.77±0.85) was recorded the highest scores of Aroma and lowest scores was recorded (6.13±0.81) in sample C. The highest score of taste were recorded (7.63±0.89) in sample D and lowest scores were recorded (6.20±0.92) in sample C. Sample D (7.40±0.81) was recorded the highest scores of Aroma and lowest scores was rescored (6.03±0.92) in sample C.

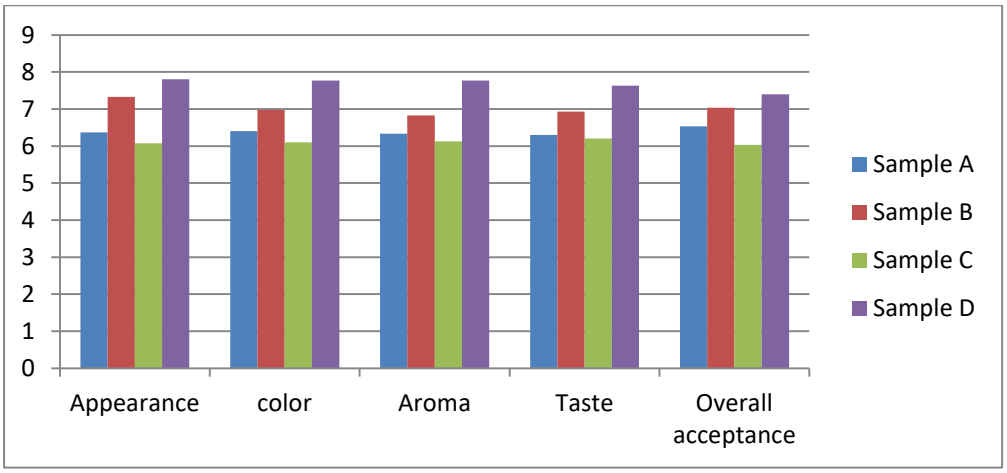

Figure 4.2: Sensory evaluation of weaning foods

Chapter V: Discussions

5.1 Nutritional composition of rice gruel and weaning food

In the experiment, the nutritional composition of three types of rice gruel powder such as Betti, Nurjahan and Balam indicates that rice gruel powder contains a high amount of carbohydrate and could therefore be a high yielding source of starch.

The moisture contents of the three formulations are 7.42%, 7.82% and 8.08% respectively and commercial complementary food is 6.50%. Moisture content in food and food products is essential because shell life by increasing microbial degradation activity, in the consequence worst odor and impermissible taste of the product (Owolabi, 2007). According to Egyptian Standard No. 3284, the recommended moisture content of infant formula is not more than 7%.

Next to water, protein is the essential component of body tissues. It is the important nutrient for growth. The body is in a potential state, with protein and other nitrogenous compounds being degraded and resynthesized incessantly. More protein is turned over every day in the body than is ordinarily consumed in the diet (Young et al.,2001).The protein contents of three formulation and commercial complementary food are 10.85%,10.76%,10.68% and 10.01% respectively. The formulated complementary food complies with the permitted levels (12%) of Food and Nutrition Board 1989 and Egyptian Standard No. 3284.

Fats and oils should be mixed to the preparation, if possible, for the aim of increasing the energy density of the complementary weaning food. Fat is an essential component of cell membranes, and it is needed in the human body for accurate cell repercussion and intracellular transportation of material. However, high levels of fat in humans have been connected with several cardiovascular diseases. The fat content of three formulation and commercial complementary food are 11.45%, 11.18%, 11.37% and 10% respectively. These levels of fat meet the minimum level recommended by the Codex standard (10-25) % (Codex, 1991).

The crude fiber contents of the of three formulation and the commercial product were 6.73%, 7.38%, 6.65%and 4.55%, respectively. The dietary fiber content of the weaning food should be reduced to a level of not more than 7 g/100 g (Codex, 1991). The crude fiber content should not be more than 2%, as recommended by the Egyptian Organization for Standardization.

Ash content is an essential parameter that may be used to evaluate the authenticity of food products (Owolabi, 2007). The ash contents of the three formulation and the commercial complementary food were 2.68%, 2.2.62%, 2.80%and 1.50%, respectively. The ash content in vegetarian baby food fortified with milk should not be more than 3%, and the content of ash that is insoluble in hydrochloric acid should not be more than 0.1%, as recommended by the Egyptian Organization for Standardization.

Carbohydrate is the main source of energy in the human body. The carbohydrate contents of the three formulations and the commercial complementary food were 60.87%, 60.24%, 60.42% and 68.26% dry weight, respectively. The Food and Nutrition Board of the National Research Council (1989) reported that more than half of the energy requirements beyond infancy should be provided by carbohydrates, with emphasis on complex carbohydrates rather than sugars. The recommended minimum intake is 50 to 100 g/day.

These findings indicated that the three complementary foods were adequate in nutrients for weaning purposes.

5.2Mineral content of weaning food

Adequate intakes of micronutrients such as iron, zinc, and calcium are important for ensuring optimal health, growth, and development of infants and young children (Huffman and Martin, 1994). The mineral contents of the three formulation and the commercial complementary foods are presented in table 4.4. The magnesium and calcium levels met the recommended values in codex standard (Codex,1991). Iron supplements given to Childs three to six months of age (5 mg of iron daily, ferrous

form) and to older Childs (10 mg daily) prevent the development of iron-deficiency anemia. The three formulation of weaning food had adequate amounts of iron and zinc. Cereals and legumes are important sources of iron, zinc, and calcium for rural infants and children (Sanny et al., 2007)

5.3 Microbial growth in weaning foods

In this study, microbial investigation was done for the 4 formulated samples A,B,C,D. This investigation was done after 1 month of made the sample. Coliform and yeast was not detected .A food product for consumption that should have microbial count should have less than 1×10^6 cfu/ml. The International Microbiological Standard recommended limit of bacteria contaminants for food of less than 10^6 cfu/g (Anon, 1974) whereas Rombouts and Nouts (1995) revealed that bacterial counts found in plants food were in the order of 12×10^7 to 10^8 cfu/g. In this investigation low bacteria counts were found because of high standard of personal was found Hygiene and quality maintenance of good manufacturing practices observed during the food formulation process.

5.4 Sensory evaluation of weaning foods

Sensory evaluation of the three formulations was deliberated one of the essential tests affecting, to large extent, their acceptability (Tewfik, 1999). Figure 4.2 shows the results of a sensory evaluation of the three complementary foods and the commercial complementary food (Cerelac). There were significant differences between the commercial and the three formulation product in appearance, color, aroma, taste, and overall acceptability. , the three formulation were less preferred ($P < 0.05$) than the commercial product (Cerelac). This could be because consumers are used to the commercial product (Ijarotimi and Aroge, 2005) and also because flavoring, sweetening, and other sensory-enhancing agents are added into the commercial product during its preparation (Ijarotimi ,2008). Unlike the commercial product (Cerelac), the three formulation did not have strong vanillin flavor and this affected its sensory scores significant ($p<0.05$) improvement in the overall acceptability of the formulated diet (A,C) upon the addition of cinnamon and vanilla (B).This observation suggests that cinnamon and vanillin can be mixed to the formulated diet

(A,C) as a means of improving the sensory qualities .This will increase the acceptability of the formulated diet(A,C) and its help the reducing the protein energy malnutrition. The current study recommends adding natural flavors or sweeteners during the formulation of the three complementary food to enhance its palatability and acceptability.

Chapter VI: Conclusion

Rice is stable food in Bangladesh. Most of the nutrients and minerals are leached out from the rice through gruel during cooking. People are not usually eating gruel, but that gruel enriched with vitamin and minerals. Corn, nut also available in Bangladesh This study concludes that rice gruel powder has high amount of carbohydrate, calcium and magnesium that is essential for child growth and development. In Bangladesh, children malnutrition is a common health problem. To ensure growth and development of children appropriate nutrition is very important. Most of the weaning foods are imported in Bangladesh are these foods are usually beyond the affordable limit of people. The study successfully created a energy dense diet that was made locally available raw materials.

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Chapter VII: Recommendation & future perspectives

In Bangladesh children malnutrition is very common problem. To reduce this health problem weaning food is very important. Childhood malnutrition occurs by the eating of weaning food of low nutrient density. Formulation and quality evaluation of weaning foods suggests the following recommendation:

- The food should be rich in calories and good quality protein, vitamins and minerals.
- The food must be tasty because children like to eat tasty food
- Spray drier should be used during drying

By adding natural flavors or sweeteners the quality of the products can be improved. The non-microbial spoilage (rancidity, browning and loss of nutrients) analysis is also important for exact nutritional value. Heavy metal content in food is increasing day by day. So the heavy metal analysis is also important. An appropriate and low cost packaging material for the product can also be selected that will protected the product from different hazard such as physical, chemical and microbiological.

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Appendices A: Photo Gallery

Appendix A1: Processing of weaning food

Rice

Cooking

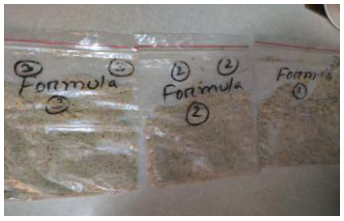
Gruel

Drying

Grinding

Dried gruel powder

Ingredient



Weaning food

Appendix A2: Pictures of laboratory activities

Weighting

Fat

Ash

Grinding

Protein

Ingredients

Panelist

Panelist

Appendix B : Hedonic Rating Test

Name: Sex: Age: Date:

Please taste this sample and check how much you like or dislike it. Use the appropriate scale to show your attitude by checking at the points that best describes your feeling about the sample Please give a reason for this attitude .Remember you are only one who can tell what you like. An honest expression of your personal felling will help me

Hedonic Scale used

Hedonic	Appearance				Color				Aroma				Taste				Overall acceptability			
	Sample				Sample				Sample				Sample				Sample			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Like extremely																				
Like very much																				
Like moderately																				
Like slightly																				
Neither like nor dislike																				
Dislike slightly																				
Dislike moderately																				
Dislike very much																				
Dislike extremly																				

Like extremely = 9, Like very much = 8, Like moderately = 7, Like slightly = 6, Neither like nor dislike = 5, Dislike slight = 4, Dislike moderately = 3, Dislike very much = 2, Dislike Extremely = 1

Comments:

Overall decision about the sample

Appendix C: ANOVA of nutritional composition of weaning foods

		Sum of Squares	df	Mean Square	F	Sig.
Moiture	Between Groups	4.485	3	1.495	1741.835	.000
	Within Groups	.007	8	.001		
	Total	4.492	11			
protein	Between Groups	1.329	3	.443	7596.333	.000
	Within Groups	.000	8	.000		
	Total	1.330	11			
fiber	Between Groups	13.529	3	4.510	135288.250	.000
	Within Groups	.000	8	.000		
	Total	13.529	11			
fat	Between Groups	4.013	3	1.338	22928.762	.000
	Within Groups	.000	8	.000		
	Total	4.013	11			
ash	Between Groups	2.993	3	.998	17103.000	.000
	Within Groups	.000	8	.000		
	Total	2.993	11			
carbohydrate	Between Groups	135.487	3	45.162	1354870.000	.000
	Within Groups	.000	8	.000		
	Total	135.487	11			
energy	Between Groups	403.960	3	134.653	4039598.250	.000
	Within Groups	.000	8	.000		
	Total	403.960	11			

Appendix D: ANOVA of mineral contents of weaning foods

		Sum of Squares	df	Mean Square	F	Sig.
mg	Between Groups	38625.000	3	12875.000	38625.000	.000
	Within Groups	2.667	8	.333		
	Total	38627.667	11			
ca	Between Groups	191400.000	3	63800.000	191400.000	.000
	Within Groups	2.667	8	.333		
	Total	191402.667	11			
fe	Between Groups	4.479	3	1.493	44792.333	.000
	Within Groups	.000	8	.000		
	Total	4.480	11			
zn	Between Groups	12.626	3	4.209	4764.513	.000
	Within Groups	.007	8	.001		
	Total	12.633	11			

Appendix E: ANOVA of sensory evaluation of weaning foods

		Sum of Squares	df	Mean Square	F	Sig.
appearence	Between Groups	59.292	3	19.764	32.612	.000
	Within Groups	70.300	116	.606		
	Total	129.592	119			
colour	Between Groups	48.358	3	16.119	22.199	.000
	Within Groups	84.233	116	.726		
	Total	132.592	119			
aroma	Between Groups	47.800	3	15.933	22.632	.000
	Within Groups	81.667	116	.704		
	Total	129.467	119			
taste	Between Groups	39.533	3	13.178	18.212	.000
	Within Groups	83.933	116	.724		
	Total	123.467	119			
OA	Between Groups	31.900	3	10.633	15.304	.000
	Within Groups	80.600	116	.695		
	Total	112.500	119			

Brief Biography

Mareya sultana passed the Secondary School Certificate Examination in 2010 and then Higher Secondary Certificate Examination in 2012.She obtained her B.Sc. (Hon's) in Food Science and Technology from the Faculty of Food Science and Technology of Chittagong Veterinary and Animal Sciences University, Chittagong, Bangladesh. Now, she is a candidate for the degree of Master of Science in Applied Human Nutrition and Dietetics under the Department of Applied Food Science and Nutrition, Faculty of Food Science and Technology, Chittagong Veterinary and Animal Sciences University (CVASU). She has immense interest to work in improving health status of poor people through proper guidance and suggestions and create awareness among people about Food Science and Nutrition.