Formulation of baby food using red kidney beans, analysis of its nutritional status, and comparison with commercial baby food

Susmita Saha

Roll No.: 0120/10

Registration No.: 839

Session: 2020 (January- June)

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

Faculty of Food Science and Technology

Chattogram Veterinary and Animal Sciences University

Chattogram-4225, Bangladesh

NOVEMBER, 2022

Authorization

I hereby declare that I am the sole author of the thesis. I also authorize the Chattogram Veterinary and Animal Sciences University (CVASU) to lend this thesis to other institutions or individuals for the purpose of scholarly research. I further authorize the CVASU to reproduce the thesis by photocopying or by other means, in total or in part, at the request of other institutions or individuals for the purpose of scholarly research.

I, the undersigned, and author of this work, declare that the electronic copy of this thesis provided to the CVASU Library, is an accurate copy of the print thesis submitted, within the limits of the technology available.

Susmita Saha

November, 2022

Formulation of baby food using red kidney beans, analysis of its nutritional status, and comparison with commercial baby food

Susmita Saha

Roll No.: 0120/10

Registration No.: 839

Session: January- June 2020

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

…………………………

Mohammad Mozibul Haque

(Supervisor)

Assistant Professor

Department of Applied Food Science and Nutrition

Faculty of Food Science and Technology

…………………………..

Ms. Nilufa Yeasmin

Chairman of the Examination Committee

Department of Applied Food Science and Nutrition

Faculty of Food Science and Technology

Chattogram Veterinary and Animal Sciences University

Khulshi, Chattogram-4225, Bangladesh

DEDICATE TO MY BELOVED AND

RESPECTED PARENTS AND TEACHERS

Acknowledgements

With a deep sense of veneration, I express my gratitude to the supreme of everything, the Almighty God to whom all praises go, who has enabled me to complete the thesis for the degree of Master of Science (MS) in Applied Human Nutrition and dietetics.

I express my sincere and deepest gratitude to **Professor Dr. A. S. M Lutful Ahasan**, Vice-Chancellor, Chattogram Veterinary and Animal Sciences University (CVASU) for giving a special opportunity and providing such research facilities.

I feel the inadequacy of my diction to find a more suitable word for a wholehearted thanks to my major advisor and supervisor **Mohammad Mozibul Haque**, Assistant Professor, Department of Applied Food Science and Nutrition, Chattogram Veterinary and Animal Science University for his guidance and moral support. His knowledge, invaluable advice, unceasing encouragement, kind demeanor and constructive criticism significantly enhanced my experience.

I am grateful to Professor **Md. Ashraf Ali Biswas,** Dean, Faculty of Food Science and Technology, CVASU for his kind cooperation and for providing the necessary facilities to carry out this research.

I would also like to convey my gratitude to all of my respected instructors at CVASU's Faculty of Food Science and Technology for their assistance in completing my research work. I also want to thank all of the employees and members of the Departments of Applied Food Science and Nutrition, Animal Science and Nutrition, and Food Processing and Engineering for their and supportiveness in carrying out the research activities accurately. I'd like to thank the Ministry of Science and Technology of Bangladesh, as well as the Center for Advanced Studies and Research at CVASU, for funding this research.

Susmita Saha

November, 2022

<u>PLAGIARISM VERIFICATION</u>

Title of Thesis: **Formulation of baby food using red kidney beans, analysis of its nutritional status, and comparison with commercial baby food**

Name of the Student: Susmita Saha

Roll number: 0120/10

Reg. number: 839

Department: Applied Food Science and Nutrition

Faculty: Food Science and Technology

Supervisor: Assistant Professor Mohammad Mozibul Haque

This is to report that as per the check _____ of the content of the above thesis is stated to be plagiarized and is covered /not covered as per plagiarism policy and institutions issued from CASR, Chattogram Veterinary and Animal Sciences University.

The thesis may/may not be considered for the evaluation.

____

Mohammad Mozibul Haque

(Supervisor)

Assistant Professor

Department of Applied Food Science and Nutrition

Faculty of Food Science and Technology

Table of Contents

List of Tables

List of Figures

Abbreviations

ANOVA	:	Analysis of variance
AOAC	:	Association of Official analytical Chemists
BRP	:	Brown rice powder
CFU	:	Colony forming unit
FAO	:	Food and Agriculture Organization
GDP	:	Gross domestic product
HCl	:	Hydrochloric acid
HNO3	:	Nitric acid
HClO4	:	Perchloric acid
KOH	:	Potassium hydroxide
ME	:	Mean
ORAC	:	Oxygen radical absorbance capacity
RDA	:	Recommended dietary allowances
RKB	:	Red kidney beans
RPM	:	Rotations per minute
SD	:	Standard deviation
TFA	:	Trifluoroacetic acid
UV	:	Ultraviolet
WF	:	Wheat flour
WHO	:	World Health Organization
WKB	:	White kidney beans

Abstract

In undeveloped areas, malnutrition is a significant public health problem because it contributes to newborn mortality, impaired physical and cognitive development in infants and early children, and decreased disease resistance. In addition to marasmus and kwashiorkor, iron, iodine, vitamin A, and zinc deficiencies also commonly appear as babies are transitioning from liquid to semi-solid or totally adult diets, which is a crucial period. The study's overarching goal is to find ways to improve early age nutrition to make up for deficiencies caused by patients' dietary practices of the past and present. This baby food was made with ingredients easily accessible in the area, including red kidney beans, barley, skim milk, almond powder, sugar, and salt. Red kidney bean was selected over black and white kidney bean due to its high mineral content. Sample C was the highest-ranking of the three baby foods tested. The nutritional breakdown of sample C was as follows: 5.3% moisture, 1.66% fiber, 10.2% protein, 8.23% fat, 1.35% ash, 73.26% CHO, and 407.91 kcal of energy per 100g. There were 346.7mg/100g of calcium, 8.36mg/100g of iron, and 320mg/100g of potassium. There was 334.74 RAE of vitamin A per 100 grams. All of these metrics showed significantly high values among the others. The most popular representation of the bacteriological quality of sample C baby food was found to be adequate. Sensory tests conducted by expert panels found that the manufactured baby food scored very highly on a nine-point hedonic scale measuring color, flavor, texture, taste, and overall acceptability. In addition, the optimally formulated sample was compared to store-bought baby food. The commercial company uses a wide variety of ingredients and flavors, and the gustatory test participants preferred it. However, Sample C performed best in terms of value for money. The baby food formula was well-balanced and sourced from easily available ingredients. The research suggests that with some adjustments to the current formulation, this food could be used as a cheaper alternative to the commercial baby food products currently on the market in Bangladesh.

Keywords: Kidney beans, red kidney beans, porridge, proximate, physical attributes, sensory quality.

Chapter 1: Introduction

Kidney beans (*Phaseolus vulgaris)* are a type of common bean. Because of the strong similarity to the human kidney, this organ serves as the inspiration for the name. In the Indian subcontinent, they are commonly referred to as Rajma. The red kidney bean (Phaseolus vulgaris) is relatively high in protein (18–25 %) and relatively low in carbs (50–60 %) among beans (Audu and Aremu, 2011; Hayat et al., 2014). They're nutrient-dense and rich in valuable compounds such as vitamins and nutrients. (Margier et al., 2018). Kidney beans are a great source of fiber and contain as much protein as a serving of vegetables. They're great alternatives to meat for vegans. A type of such common bean (*Phaseolus vulgaris*), kidney beans originated in Central and South America and were later introduced to Mexico. Because of its high protein content, this grain legume can be used to supplement cereal-based diets, particularly in developing countries.(Akubar Akubor et al., 1999). It's also high in crude fiber and full of healthy nutrients.(Fikru et al., 2014). In many parts of the world, the common bean is the primary source of protein in the diet. White, cream, black, red, purple, spotted, striped, and mottled are just some of the colors and patterns available. There are numerous vitamins, minerals, and protein-building amino acids found in kidney beans. Complete with everything you need for a nutritious diet, it's a one-stop shop.(Clark et al., 2021). An ideal source of vegetable protein, carbs, vitamins, fiber, and minerals can be found in the red kidney bean.(O Romero-Arenas et al., 2013). Beans make up 32% of Rwandans' calorie intake and roughly 65% of one ‘s protein intake, while only 4% of their protein comes from animal sources. While almost all (99.9%) rural residents consumed beans in the previous seven days prior to the interview, with the average bean consumption frequency being six days a week, according to the Harvest Plus varietal adoption survey. (Mulambu J, 2017). The tannin content and trypsin inhibitor activity can be lowered by blanching, soaking, and dehulling, and the phytic acid content can be lowered by cooking, increasing nutrient availability and improving protein digestibility (Chaudhary and Sharma, 2013).

Complementary foods that are high in nutrients are necessary to ensure a baby gets the proper amount of food they need. Although traditional complementary foods often fall short of nutrient recommendations, fortified manufactured baby foods may play a role in ensuring adequate nutrition. Children are especially susceptible to the negative health, growth, and development effects of malnutrition during the complementary feeding period (World Health Organization, 1998). Growth slows between 6 and 24 months of age in malnourished infants and young children living in resource-limited environments. When the amount of breast milk consumed by a baby is unknown, nutrient concentration can be used to determine which nutrients may pose a problem when planning an appropriate feeding diet (Dewey and Adu-Afarwuah, 2008). It is crucial to supplement breast milk intakes with sufficient quantities of healthy, age-appropriate foods. There is evidence that traditional food-based complementary feeding diets won't satisfy recommended nutrient density levels, particularly for iron, calcium, and zinc. This evidence comes from data on food composition, diet modeling, and dietary surveys. This is due to the traditional foods' low nutrient content when compared to the estimated nutritional needs of infants (Ferguson and Darmon, 2007).

Overall, manufactured baby foods may play a significant role in enhancing the nutritional profile of conventional complementary feeding dietary patterns and the iron status of infants provided they are accessible, cost effective, fortified at adequate level with bioavailable fortificants, and marketed in a risk-free manner (Ferguson and Darmon, 2007). While commercial baby foods are readily available, the vast majority of people in developing countries cannot afford to buy them. One such protein source that, if included in baby foods, could greatly improve their nutritional status is the kidney bean. Thus, this study was conducted to create a nutrient-dense baby food for the young children of Bangladesh with readily accessible materials and low-cost technology.

Aims and objectives:

The purpose of this research was to combine inexpensive ingredients like beans, barley, almond powder, skim milk powder, sugar, and salt into baby food that is high in both nutrients and energy.

This food will help to meet the nutritional needs of a young baby during a critical time in their development. The study aims to accomplish the following things:

1. The mineral content of black, white, and red beans will be analyzed so that they can be processed accordingly.
2. Prepare nutritious and healthy baby food for children aged 3-5 years old.
3. Make various baby food varieties and evaluate their nutritional qualities.

Chapter 2: Literature Review

2.1 Overview of kidney bean

Beans, which are from the Fabaceae family of legumes, are grown and eaten all over the world due to their high nutritional and economic value (Punia et al., 2020). Protein (20%), complex carbs (50%-60%), and a good amount of vitamins, minerals, and poly-unsaturated fatty acids make kidney beans (*Phaseolus vulgaris*) an essential part of human diet (Gonzalez and Paredes-Lapez, 1993; Rehman et al., 2001), and appreciable amount of folate and fiber (Shi et al., 2007). Starch makes up 25%-45% of the storage polysaccharide in kidney bean seeds (Shi et al., 2007). The major kidney bean seed storage polysaccharide is starch accounting 25%–45% (Yoshida et al., 2003). Starch is the primary carbohydrate used by plants for storage; it also provides between 50 and 70 percent of the human diet's total energy. Sauces, soups, candies, sugar syrups, ice cream, snacks, meat products, baby foods, and fat replacers are just few of the many items that regularly incorporate this ingredient (Copeland et al., 2009). Starch and its byproducts are becoming increasingly popular due to the rising demand for fast meals. We employ carbohydrates from corn, wheat, and potatoes in a broad variety of contexts. To accommodate the industry's growing demand, it would be helpful to find alternatives to these commercial starch sources(Ngobese et al., 2018).

There are numerous types of kidney beans, and it is well known that each type has distinctive seed size, shape, and color (Tsuda et al., 1994). Red, black, brown, and white colors are frequently seen in kidney beans, which have a particularly wide range of hues (Choung et al., 2003). Among these hues, the red and black pigments in kidney bean seeds make a favorable potential source for natural food colorants (Takeoka et al., 1997).

2.1.1 Overview of black kidney bean

The amount of protein found in black beans is larger than that found in soybeans and even surpasses the amount of protein found in meat, eggs, and milk. In addition, black beans are an excellent source of high-quality protein; they also have a healthy proportion of amino acids; and they are nutritionally abundant not only in terms of calories, but also in terms of isoflavones, vitamin E, saponins, carotenoids, and anthocyanins (Jiang et al., 2014; Lee et al., 2008), but also in polyphenols (Takahashi et al., 2005)

2.1.2 Overview of white kidney bean

White Kidney Beans (WKB) are a well-known type of legume that includes a wide variety of antioxidants, as well as proteins, minerals, and vitamins, in addition to carbohydrates. It has been demonstrated that diets consisting of WKB can considerably lower plasma lipid levels in animals who are hyperlipidemic (Metwalli et al., 1993) and could make one lose weight (Chokshi, 2007). Diabetic rats' hyperglycemia was decreased by the amylase inhibitor from WKB (Tormo et al., 2006). When anemic rats were given meals prepared from either lentils or WKB, the comparison revealed that the WKB meal produced much higher levels of iron bioavailability and liver store than the lentils meal (Martínez-Zavala et al., 2016). By altering signaling pathway genes in rats, WKB non-digestible fibers have been shown to benefit an initial onset of colorectal cancer (Haydé et al., 2012).

2.1.3 Overview of red kidney bean

The red kidney bean is a herbaceous legume that is a member of the leguminosae family. It is an excellent source of starch, protein, soluble and insoluble fiber, mineral (potassium, phosphorus, iron, magnesium, and so on), and vitamin B. Produced in dry and tropical temperature zones across the globe, the Red Kidney Bean is a type of kidney bean. Scientific Classification of Red Kidney Bean:

Domain: Eukaryota

Kingdom: Plantae

Phylum: Spermatophyta

Subphylum: Angiospermae

Class: Dicotyledonae

Order: Fabales

Family: Fabaceae

Genus: Phaseolus

Species: Phaseolus vulgaris

Source: www.cabi.org

Because it is an excellent source of plant-based protein, the red kidney bean is a popular food item in Bangladesh. However, in the vast majority of instances, they are consumed by the general populace after undergoing just a little preparation, such as drying or canning, for example. The high protein content of red kidney beans makes them a useful ingredient for developing new products with added value.

2.1.3.1 Proximate and nutritional importance of red kidney bean

Because of their increased protein content, legumes are commonly referred to as "poor man's meat." Legumes have the ability to tackle the problems of protein energy malnutrition, particularly in developing nations (N Qayyum et al., 2012. Additionally, the red kidney bean is a significant crop for the legume family and is extensively grown in the geographic regions of Asia, South America, and Africa (Wani et al., 2010. The red kidney bean, also known as *Phaseolus vulgaris*, is famous for the high levels of fiber, minerals, vitamins, and protein that it contains (Osorio-Díaz et al., 2003. It has a preventative impact against cardiovascular illnesses, diabetes, and other chronic diseases due to the fact that it is a good source of fiber, which helps decrease cholesterol (Aparicio-Fernandez et al., 2005). Red kidney beans are rich in dietary fiber, starch, vitamins, minerals, and a wide variety of phytochemicals, but their high protein content which is 2-3 times that of cereal grains is the most significant aspect of their nutritional value. Despite the fact that red kidney beans are rich in dietary fiber, starch, vitamins, minerals, and a huge assortment of phytochemicals, they also have a high protein content.(Mundi and Aluko, 2012).

The proximate composition of a food product might change due to processing activities like heating. Hence, understanding the red kidney bean's proximate composition is crucial. According to the Ikechukwu, 2017, The percentages of water, fiber, fat, protein, carbohydrates, and ash found in red kidney beans are 1.06±0.11, 4.00±0.011, 1.57±0.005, 20.31±0.011, 68.03±0.13, 5.00±0.00 respectively. Contrarily, red kidney bean seeds were found to contain 53.02±1.14%, 25.78±0.77%, 6.82±0.31%, 1.92±0.15% and 4.34±0.20%, respectively, of carbohydrates, crude protein, crude fiber, crude fat, and ash (Hayat et al., 2014).

Oxygen radical absorbance capacity (ORAC) laboratory tests have shown that, out of more than a hundred commonly consumed fruits and vegetables, red beans have among the highest antioxidant capabilities (Wu et al., 2004).

While cereal grains do provide some protein, red kidney bean proteins provide more of a necessary amino acid called lysine. Therefore, due to the nutritional redundancy of essential amino acids, a balanced protein diet can be achieved by the ingestion of both beans and cereals (Tang et al., 2009).

2.1.3.2 Baby food and red kidney bean:

It was discovered that there was a quantitatively very small to zero affiliation between increases in per-head GDP and decreases in early childhood undernutrition. This For this reason, many supplementary feeding programs in underdeveloped countries focus on children between the ages of 6 and 24 months, when stunted development, micronutrient deficiencies, and infectious diseases are most common. The consequences of malnutrition on stunting are more difficult to cure after the age of 2 years, and some functional deficiencies may be irreversible. Therefore, it is crucial to prioritize measures that can effectively reduce malnutrition during this sensitive period. Food-based, comprehensive approaches may be more successful and durable than programs addressing individual nutritional deficiencies, however there are a variety of interventions that can be directed at this age group (such as micronutrient supplementation). The term "complementary feeding interventions" is used in a broad sense throughout this evaluation to encompass the many possible approaches (Dewey and Adu-Afarwuah, 2008). This makes red kidney beans an affordable protein option, especially for the poor in developing countries (Yin et al., 2010).

2.2 Anti-nutrient property of red kidney bean

Humans and animals alike rely on legumes as a source of protein in their diets, but the nutritional quality of foods like the red kidney bean can be negatively impacted by the presence of toxins like phytate, tannins, and oxalate, which are collectively known as anti-nutritive factors because of their ability to interact with the intestinal tract and decrease protein digestibility and amino acid absorption (Audu and Aremu, 2011). *Phaseolus vulgaris*, or red kidney beans, contains high concentrations of lectins, which can have both helpful and harmful effects on living organisms. Lectins are carbohydrate-binding glycoproteins with the ability to react selectively with human blood cells, agglutinate malignant cells preferentially, and stimulate lymphocyte mitogenesis. When introduced into the bloodstream, some lectins may withstand heat and proteolytic enzymes and reach their target (Zhang et al., 2009).

According to (Liener, 1994) these compounds can have harmful physiological consequences when swallowed by humans and other animals unless they are first eliminated through heat or other treatments.

Grain legumes (pulses) are seen as an important source of nutrients and as a poor man's meat, highlighting their significance for people in developing nations where the consumption of animal protein is constrained by scarcity or is self-imposed due to religious or cultural customs. Additionally, pulses contain a variety of bioactive substances that are present in food in trace amounts but which may have important metabolic and/or physiological effects. These substances have long been regarded as antinutritional elements, but numerous studies have reevaluated their effect on health. Some might contribute to the suppression of the main ailments that plague wealthy societies. In order to decide whether these compounds should be preserved or eliminated in each of the major nutritional situations, an assessment of their various physiological effects is required because they can either be advantageous or detrimental depending on the circumstances (Champ, 2002).

Chapter 3: Materials and methods

3.1 Study area

The experiment was conducted in the lab of the Chattogram Veterinary and Animal Sciences University's Department of Applied Food Science and Nutrition, Department of Food Processing and Engineering. From June 1 to November 30, 2022, a six-month experiment was run.

3.2 Collection of samples

Three different varieties of kidney beans were procured from the Roazarhat Bazar and Pahartoli local markets in Rangunia, Chattogram. Barley, sugar, salt, skim milk powder, and almonds were some of the additional ingredients that were purchased from the local market and superstore. The lab stockpiles provided access to additional supplies that were required for the experiment.

3.3 Design of experiment

The availability of several minerals was investigated by testing three varieties of kidney beans (red kidney bean, white kidney bean, and black kidney bean). This study focused on the kidney beans' calcium, iron, and potassium content, though they include many other nutrients.

According to the result, red kidney beans were selected for further experiments. Once it was done the red kidney beans were grounded into powder. Then, the components were blended together in various ratios. Three types of baby food formulas were made and indicated as Type A, Type B, and Type C.

Baby food's proximate composition (moisture, ash, crude fat, protein, and crude fiber), vitamins A, and minerals (Ca, Fe, K) were examined after processing. Panel members were asked to rate how satisfied they were with three different versions of the same product (samples A, B and C). Proximate analysis, nutrient content, microbial load, and customer acceptability testing were conducted for each product type. Similar testing was done on one of the controls. Red kidney bean was chosen for additional testing based on the outcome. When that was accomplished, the red kidney beans were mashed into a fine powder. After that, the ingredients were mixed in different proportions. There were three different baby food formulations created and labeled A, B, and C.

After being processed, baby food was tested for its proximate composition (moisture, ash, crude fat, protein, and crude fiber), vitamin A, and mineral content (Ca, Fe, and K). Three variants of the same product were presented to the panel, and their satisfaction was evaluated (samples A, B and C). Products of every kind were put through a series of tests, including those for proximity, nutrient content, microbiological load, and panel member's acceptance. One of the controls also underwent identical tests.

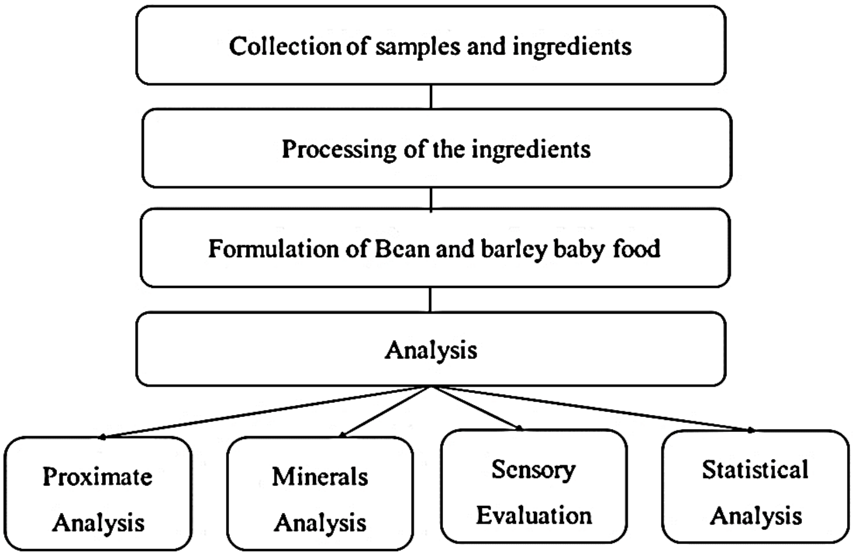


Figure 3. 1: Study design

3.4 Powder preparation

3.4.1 Preparation of bean powder

The red kidney beans were soaked for six hours at room temperature before being cooked for fifteen minutes. Half of the beans were then dehusked and allowed to cool to room temperature. After that, we spread out the husked and dehusked beans on a tray and dried them at 60°C for 24 hours in a cabinet dryer. Fine powder was made by grinding dried seeds in a grinder and then sieving the resulting powder. After being wrapped in a zipper bag, the powder was transferred to an airtight container for later.

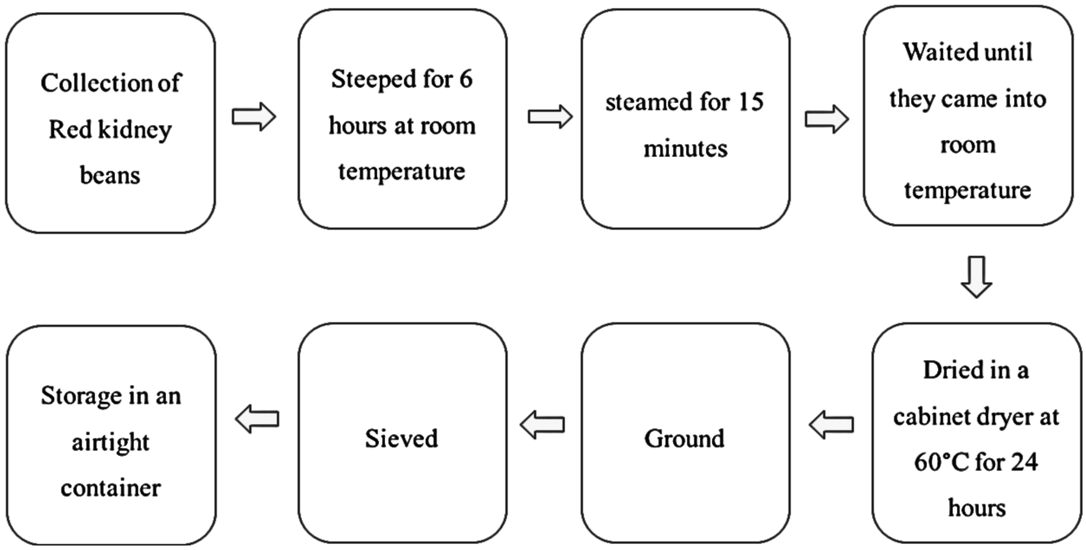


Figure 3. 2: Preparation of bean powder

3.4.2 Preparation of almond powder

Almonds were initially purchased from the store. The almonds were then roasted for ten minutes over a medium flame. The almonds were then set aside to cool. Next, a grinder was used to grind the almonds at a moderate speed. The ground almonds were sieved and stored in the fridge in an airtight container until further analysis.

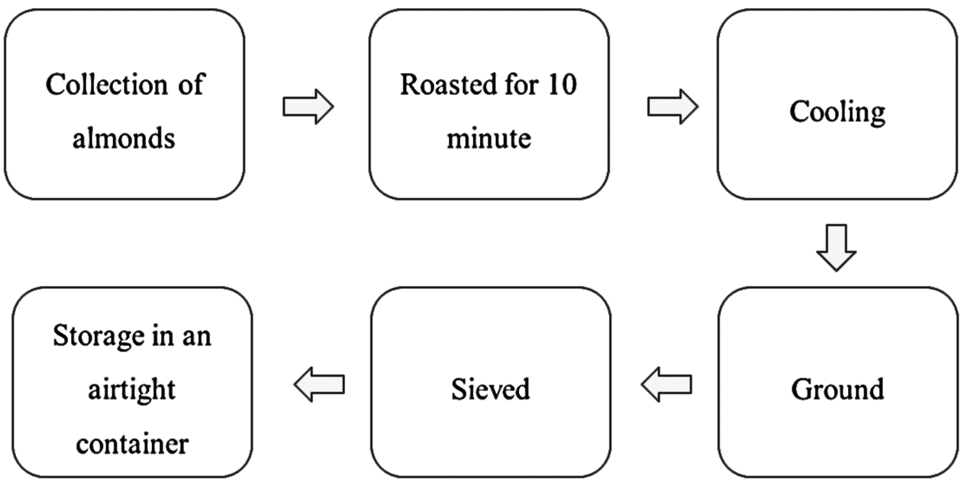


Figure 3. 3: Flow sheet for preparing almond powder

3.5 Preparation of experimental bean- barley baby food powder

Baby food is made from bean and barley in three distinct varieties. These tests were performed to ensure the quality of the final product. Various products had different bean powder and barley powder percentages. The food sample also had the same percentages of almond powder, skim milk powder, sugar, and salt. Once the desired texture, consistency, flavor, and general acceptability had been achieved, the ingredients were combined. The compositions of three different formulated Bean-barley baby food are shown in table 3.1.

Table 3. 1: Composition of experimental bean- barley baby food formula

Ingredient	Control	Baby food formula with 10% bean powder (Sample A)	Baby food formula with 15% bean powder (Sample B)	Baby food formula with 20% bean powder (Sample C)
Barley Powder	50	40	35	30
Red kidney bean powder	-	10	15	20
Almond powder	5	5	5	5
Skim milk powder	14	14	14	14
Sugar	30	30	30	30
Salt	1	1	1	1

3.6 Processing of bean- barley baby food powder

The quantities listed in Table 3.1 were used to weigh each ingredient. Powdered beans, barley, almonds, skim milk, sugar, and salt were added and blended. In order to ensure that the above mixture's particles were evenly dispersed, they were ground. The packaged baby powder was taken along for nutritional and sensory testing.

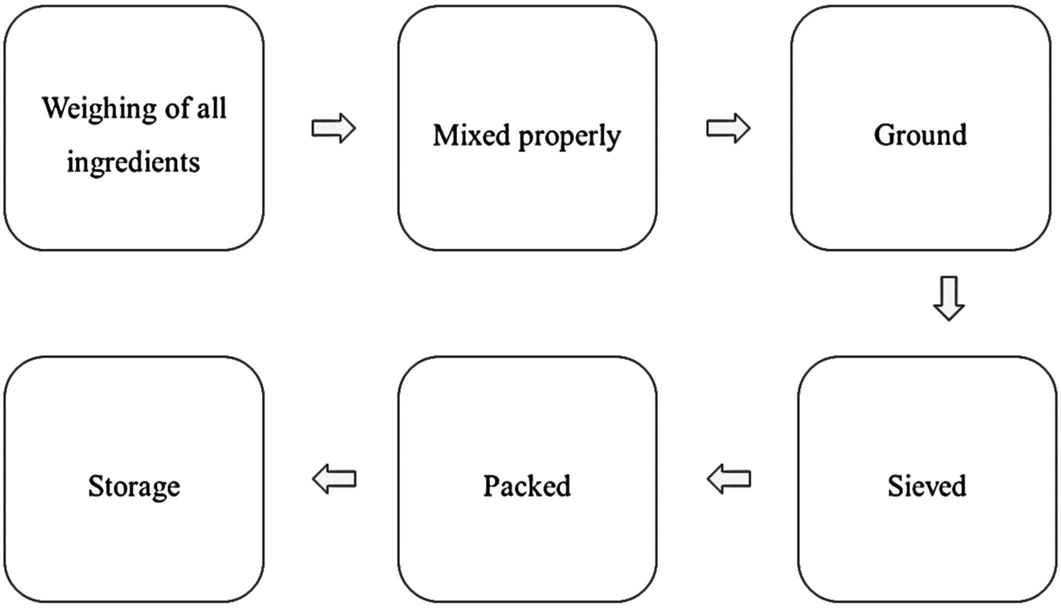


Figure 3. 4: Formulation of bean- barley baby powder

3.7 Proximate analysis of bean- barley baby food powder

3.7.1 Moisture content

The moisture content of enhanced Bean- barley baby food powder was determined using the (AOAC, 2000). The crucibles were prepared for use after being washed, dried for three hours at 105°C, and chilled in desiccators. Next, each crucible was weighed to ensure accuracy. They put about 2 grams into the crucible. For 48 hours at 105°C, the sample was dried after being placed in the crucible. After the crucibles were dried in dehydrators, they were cooled using water. Once the crucibles had cooled, their weights were recorded. The formula in the equation was then used to get the relative humidity.

$$\%\ of\ Moisture\ Content = \frac{W1 - W2}{W2}$$

Where,

$W1$= weight of the sample (g) before drying and

$W2$ = weight of the sample (g) after drying

3.7.2 Crude protein content

The crude protein content of the enhanced Bean- barley baby food powder was calculated using the macro Kjeldahl technique 920.87. On oiled filter paper, I weighed around 1g of sample material. The contents were then wrapped and placed in a Kjeldahl digestive tube with a 100cc capacity. Five milliliters of concentrated sulfuric acid and two grams of Kjeldahl catalyst were added to each 100 milliliter digestive tube, and a filter paper blank was also made. Further digestion of the samples released the nitrogen from the heterocyclic ring, resulting in a clear blue solution. When 40 ml of 40% sodium hydroxide was added to 50 cc of the digest, the ammonia generation time was cut in half. A 50 mL flask containing 4% boric acid was used to collect the steam distillation vapors that resulted. The distillate was titrated against a 0.1520 N HCl standard solution using a bromocresol green/methyl red combination as the reagent. The following formula was used to derive the nitrogen content.

$$\text{\% Of Nitrogen} = \frac{Titre\ (blank) in\ ml \times Conc. of\ acid\ N/mol}{weight\ of\ sample\ (g)} \times 100$$

Protein content was determined by multiplying the nitrogen content by a factor of 6.25 for plant sources (equation).

$$\%\ of\ CP = \%\ N \times Factor\ (6.25)$$

3.7.3 Crude fiber content

The dietary fiber content of enriched Bean- barley baby food powder was determined using the Fiber Method 920.86. To determine the amount of crude fiber in each sample, one gram was taken. Materials were rinsed three times with hot water after being steeped in 0.125M diluted sulfuric acid for 30 minutes. After being digested in a moderate alkaline solution (0.125M KOH) for an additional 30 minutes, the residue was washed three times with hot water. After five hours of cooking, the leftovers were digested, cooled, and weighed. After two hours in a muffle furnace at 525 degrees Celsius, the ash was weighed again. The total quantity of fiber was determined by the following formula:

$$\%\ of\ \text{fiber} = \frac{W1 - W2}{W}$$

Where,

$W1$= weight of the sample (g) before drying

$W2$ = weight of the sample (g) after drying

W = weight of dry sample(g) taken for determination

3.7.4 Crude fat content

The (AOAC, 2000) method employs Soxhlet apparatus to calculate the total crude fat content of the samples. Samples were dried and then stored in thimbles with fat-free cotton fiber on top. Once the fat extraction tube was attached to the Soxhlet device, the thimble was placed into it. About 75 ml of anhydrous petroleum ether were put through the sample tube and into the flask. The tip of the fat-extracting tube was linked to the condenser. The extraction process lasted for at least 16 hours, taking place in a water bath kept between (70) and (80) degrees Celsius. Once the features had been extracted, the thimble was taken off the machine and the petroleum ether were distilled or collected in a Soxhlet tube. To remove impurities, refined petroleum was poured via a tiny funnel into a weighted, dry beaker. The flask was given a thorough cleaning with a large amount of petroleum ether. After being evaporated in a steam bath at room temperature, the petroleum ether was dried for 1 hour at 100°C, then chilled, and finally weighed. Changes in relative density were used to determine which components of the sample were soluble in ether. The percentage of fat in the crude food was written as follows:

$$\text{\% Of Crude fat} = \frac{Weight\ of\ ether\ soluble\ material}{Weight\ of\ sample\ taken} \times 100$$

3.7.5 Ash content

The ash content was calculated utilizing (AOAC, 2016) procedures. Ash is the inorganic residue that remains after organic matter has been burned or otherwise destroyed. The empty crucible was then dried at 105°C for an hour in a desiccator before being weighed repeatedly until it achieved a stable value. About a gram of sample was dropped into the empty, weighted crucible. The sample was combusted over a low flame after a single drop of nitric acid was added to the crucible. The crucible was then placed into a muffle furnace and heated to 650 °C, where it remained for three hours. After the crucible containing the ash had been weighed, the ash was removed, allowed to cool, and stored in a desiccator. For the calculation of the ash content, the following formula was used,

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

3.7.6 Carbohydrate

Using the difference method as described by (Edeogu et al., 2007) the total percentage of carbohydrates was calculated. The amount of readily available carbohydrates is calculated by deducting the total of moisture, ash, protein, and fat values (per 100 gm) from 100. The following formula was used to determine the carbohydrate content.

% Carbohydrate = 100 – (Moisture + Ash + Protein + Fat)

3.8 Energy estimation

The following equation was used to calculate the energy content of each sample according to (Baer et al., 1997)

Energy = (Protein × 4.1) + (Fat × 9.2) + (Carbohydrate × 4.1)

3.9 Mineral content

Minerals are absorbed from the food matrix and then absorbed again after digestion. A sample of baby food was acidified using a mixture of HNO_3 and $HClO_4$ at a ratio of 2:1. A one-gram sample was weighed and transferred to a conical flask for further study. To ensure complete digestion, 7 ml of HNO_3 and 3 ml of $HClO_4$ were added to a flask, and the whole thing was placed on a hot plate at 200W for 3 minutes. After cooling, the solution was filtered into a filter-lined 100 ml standard flask and subsequently diluted with distilled water. This solution was used to determine the mineral concentration. The concentrations of individual minerals (potassium, calcium, and iron) were determined using a UV visible spectrophotometer (Humalyzer 3000). For the biochemical analysis, I used a premade commercial kit (Radox). The results were shown as a percentage in milligrams per one hundred grams.

3.9.1 Iron content

The ferrous ion, which is released in an acidic environment, can be returned to its bivalent state with the help of ascorbic acid. Iron ions make ferrozine a colorful molecule. The hue's intensity is based on how much iron was present in the sample. Blank solutions were prepared using pipette full of 1 ml reagent, while standards were prepared using 200 L of standard and 1 ml of reagent. It took 200 liters of sample extract and 1 milliliter of reagent to make the sample solution. After the ingredients were combined, a 10-minute incubation period was carried out at room temperature. To calculate absorbance, we compared a blank to the standard and sample. The levels of iron were measured and reported in g/dl, or micrograms per deciliter.

3.9.2 Calcium (Ca) content

Ca ions combining with O-Cresolphthalein to form a violet complex is catalyzed by an alkaline environment. For the purpose of preparing a reagent blank solution, 25 L of distilled water and 1 ml of working reagent were each placed inside of a cuvette. It was decided to combine one milliliter of the working reagent with twenty-five milligrams of the Ca^{++} standard. The sample solution was produced by adding one milliliter of the working reagent to 25 liters of sample extract and mixing the two volumes together. Measurements of the sample's absorbance as well as the reference's absorbance were obtained. The quantity of calcium is expressed as milligrams per milliliter, and the standard concentration is calculated by multiplying this value by the ratio of the sample absorbance to the absorbance of the standard.

3.9.3 Potassium (K) content

The reaction between potassium tetraphenylboron and sodium tetraphenylboron causes a very minor cloudiness in the potassium tetraphenylboron. The turbidity of a sample can be used to determine the amount of potassium that it contains. To prepare a blank solution, just mix one milliliter of potassium reagent with two milliliters of deionized water in a cuvette. This will provide the desired amount of solution. To prepare the standard solution, one milliliter of potassium reagent and two microliters of sample extract were each put to a cuvette. After being mixed, this fluid was kept inside the incubator for a period of five minutes. We completed the comparison of the absorbance of the blank, the Standard, and the sample inside of 15 minutes. The potassium concentration was calculated and granted as mg/dl after multiplying the sample absorbance to standard absorbance ratio by the standard concentration (in milligrams per deciliter).

3.10 Vitamin A content

Utilizing a colorimeter, vitamin A was measured. The total Vitamin A content of a particular food was calculated using both retinol and beta-carotene contributions. Alcohol was used to precipitate proteins, and light petroleum was extracted from retinol and carotenoids. The light petroleum was evaporated, the carotenoid-induced yellow color intensity was measured, and the residue was then dissolved in chloroform prior to the color reaction. The reaction's contribution from the carotenoid was taken into account. (Bradley and Hornback, 1973). Trifluoroacetic acid (TFA) reacts with the retinol in the sample. A blue color was seen during the sample and TFA reaction, indicating the presence of retinol in the sample. Since the blue color was momentary, it must be noticed as soon as possible after adding the reagent, within two seconds. (Guamuch et al., 2007). To prepare each sample Using a vortex mixer, 100 mg of the sample, 1 ml of distilled water, and 2 ml of ethanol were combined in a tube. 1 ml of the supernatant was removed after the tube had been centrifuged for 15 minutes at 3000 rpm. Carotene was discovered initially. 6 ml of the B reagent was used to prepare the blank solution, and 6 ml of the standard reagent were pipetted into the cuvette. To prepare the sample solution, a pipette was used to transfer 1 ml of sample extract, 2 ml of A reagent, and 3 ml of B reagent into a cuvette. All were thoroughly mixed with a vortex mixer and a mechanical shaker for ten minutes. 10 minutes were spent centrifuging the tubes at 3000 RPM. 2 ml of sample supernatant, a standard, and a blank were used to measure the absorbance at 420 nm in comparison to the blank. The quick completion of this was done to prevent the solvent from evaporating and the light from destroying the carotenoids. Then the retinol was determined. The sample cuvette's contents were evaporated to dryness in a water bath at 50°C using 2 ml of sample extract (C), which was prepared for the carotene determination. In the sample cuvette, 100 µl S4 reagent and 1 ml S5 reagent were added after the solvent had evaporated. S4 and S5 reagents in volumes of 100 µl and 1 ml, respectively, were pipetted into cuvettes to prepare the blank solution. To prepare the standard solution, 100 ml of the standard reagent and 1 ml of the S5 reagent were used. A vortex mixer was used to thoroughly combine these. At precisely 2 seconds after adding the reagent, the absorbance was measured at 620 nm. due to the S5 reagent's strong acidic nature and irritating vapor. Following are the measurements for carotene, retinol, and total vitamin content:

$$\text{Retinol (mg/l)} = (0.0759 \times \text{Absorbance}) + 0.1023$$

Carotene (mg/l) = (- 0.0167 × Absorbance) + 0.0091

Where, 0.0759 and 0.0167 are slope; 0.1023 and 0.0091 are intercept.

Total vitamin A (RAE) = μg of retinol + (μg of beta-carotene / 6)

3.11 Sensory evaluation

Sensory assessment using the hedonic scale was used to gauge the level of consumer approval. The hedonic 9-point scale is a helpful tool for anyone assessing food preferences or general food enjoyment. The created product's potential market success was determined by a taste-testing panel. 20 trained panelists who were both CVASU instructors and students participated in the sensory evaluation assessment at the university's facilities. Samples A, B, and C each have their unique formula encoded. The panelists randomly selected samples from the three sets without being given any instructions.

The use of a hedonic scale with 9 points allowed for the assignment of descriptive adjectives to various quality criteria such as appearance/color, texture, smell, taste, and overall acceptability. The evaluation was carried out in the laboratory of the department of Applied Food Science and Nutrition at Chattogram Veterinary and Animal Sciences University (CVASU) while the temperature was kept at room temperature. Before beginning the sensory test, oral agreement was obtained from each panelist to ensure that they voluntarily participated in the sensory analysis. This was done before the test even began. The scale was structured so that: 9=Like exceedingly, 8 = Like very much, 7 = Like, 6 = Like slightly, 5 = Neither like nor dislike, 4 = Dislike slightly, 3 =Dislike moderately, 2 = Dislike, 1 = Dislike greatly. During the process of scoring, the greatest possible score (9) was given to the quality that was desired the most, and the lowest possible score (1) was given to the quality that was desired the least. This method does not, of course, reflect the actual consumer view; but it does strongly highlight the traits that a product of good quality should possess.

3. 12 Statistical analysis

For the purposes of conducting additional statistical analysis, the information was entered into a spreadsheet created in Microsoft Excel 2019. Every sample was utilized thrice in total. In the sensory analysis of the baby food formula made with bean and barley, descriptive statistics such as mean and standard deviation were utilized. Using Minitab 19 for Windows, the data was structured, coded, and recorded after being organized. After that, a statistical examination of the findings was carried out. In order to generate a 95% confidence interval for the degree of significant variation, data on proximate composition, phytochemicals, antioxidant capacity, and sensory evaluation were evaluated using one-way ANOVA procedures. In order to identify the variations in variance that exist between the groups in the samples, a post hoc test known as the Fisher test was carried out. In the statistical study, a level of significance of 5%, denoted by $P<0.05$, was chosen.

3.13 Cost analysis

When estimating the price of the bean- barley baby food, the total cost of the ingredients used in its production was taken into consideration. The total was displayed in taka and contrasted with the cost of each commercial product package.

Chapter 4: Results

4.1 Nutritional attributes

Mineral contents of three types of kidney beans (Red, White, and Black) were evaluated by following the methods described earlier. Bean- barley baby food powder's nutritional qualities were evaluated by looking at its moisture, protein, fat, crude fiber, ash, and carbohydrate contents. Mineral contents of the Bean- barley baby food powder was also checked. The nutritional qualities of the best formulation were contrasted with those of commercial foods that were readily available in the area.

4.1.1 Mineral contents of three types of kidney beans (red, white, and black)

Analysis of mineral content such as calcium (Ca), iron (Fe) and potassium (K) of different formulations were measured in baby food powder demonstrated below:

Table 4. 1 Mineral content of three types of kidney beans

Kidney beans	Calcium	Iron	Potassium	1-P Value
Red kidney beans	1016.7±75.70[a]	15.157±0.17[a]	1546.7±40.40[a]	0.001
Black kidney beans	236.7±40.40[b]	7.256±0.16[b]	983.3±35.10[b]	0.001
White kidney beans	273.3±45.10[b]	7.303±0.13[b]	743.3±20.80[c]	0.001

Legends: Values in the same column with the same superscripts but different Means ± SD are not statistically significant (P<0.05).

4.1.2 Nutritional composition of bean- barley baby food

The results of proximate analysis of four different formulations are illustrated on Table-4.2. They are compared with control.

Table 4. 2 Proximate analysis of nutrient enriched baby food

Variables	Control	Sample A	Sample B	Sample C	1- P value
Moisture (%)	6.78 ± 0.03 [a]	6.61 ± 0.04 [a]	6.12 ± 0.015[c]	5.3 ± 0.30[c]	0.001
Crude fiber (%)	1.06 ± 0.11 [c]	1.11 ± 0.01 [c]	1.37 ± 0.20 [b]	1.65 ± 0.03[a]	0.001
Crude protein (%)	5.69 ± 0.02[d]	7.59 ± 0.05[c]	9.70 ± 0.05 [b]	10.2 ± 0.20[a]	0.001
Fat (%)	7.77 ± 0.02[c]	7.83 ± 0.05[c]	7.98 ± 0.02[b]	8.23 ± 0.03[a]	0.001
Ash (%)	1.10 ± 0.10[b]	1.29 ± 0.04[a]	1.29 ± 0.01[a]	1.35 ± 0.02[a]	0.001

Legends: Values in the same row with the same superscripts but different Means ± SD are not statistically significant (P<0.05).

4.1.3 Mineral content

Table 4.3 showed the mineral contents of three formulated baby foods. Significant components of Bean- barley baby food also include important minerals such as calcium, iron, magnesium, zinc and potassium. Among the three types we can see from table 4.4 type B contains highest amount of Iron, Magnesium, calcium and Potassium and lowest amount of minerals contains by Type C.

Table 4. 3 Mineral contents of nutritionally enriched baby food

Variables	Control	Sample A	Sample B	Sample C	1-P Value
Calcium	214±16.37[c]	233.3±25.2[c]	276.7±20.80[b]	346.7±25.20[a]	0.001
Iron	3.22±0.07[d]	4.69±0.14[c]	5.26±0.07[b]	8.36±0.16[a]	0.001
Potassium	146.7±35.10[c]	226.7±25.20[b]	266.7±25.20[ab]	320±36.10[a]	0.001

Legends: Values in the same row with the same superscripts but different Means ± SD are not statistically significant (P<0.05).

4.1.4 Energy content

Energy concentration was obtained from Figure 4.1, with sample C got the largest amount (407.91 Kcal/100 g) and sample A having the lowest amount (403.04 Kcal/100 g).

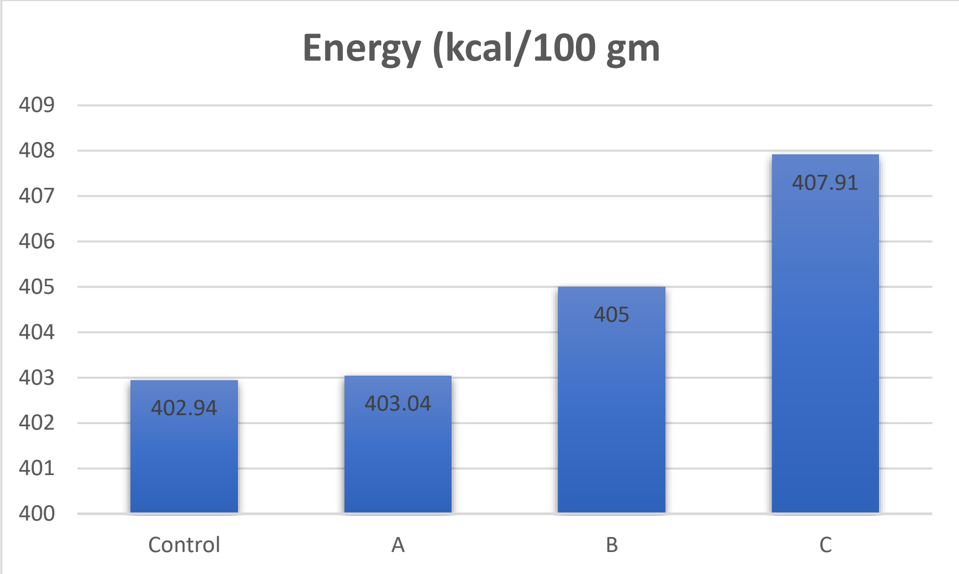


Figure 4. 1 Evaluation of energy content in control and formulated baby foods.

4.1.5 Vitamin A content

Table 4.4 had the results for the amount of vitamin A discovered in manufactured baby foods. According to the table, C showed a noticeable increase, while A showed the lowest value.

Table 4. 4 Vitamin A content in prepared baby foods

Formulations	Vitamin A (µg RAE/100g)
A	307.63 ± 1.02^{c}
B	317.83 ± 1.65^{b}
C	334 ± 16^{a}

Legends: Values and Means ± SD are statistically significant (1-P Value 0.001).

4.1.6 Sensory evaluation

Results for sensory attributes, including appearance, texture, smell, taste, and overall acceptability are shown in Table 4.7. The comprehensive acceptability of Type C baby food was significantly higher compared to Type A and Type B.

Table 4. 5 Evaluation of hedonic ratings for assessing the sensory quality of prepared baby food

Formulation	Control	Sample A	Sample B	Sample C	1-P Value
Appearance	5.0 ± 1.00^{b}	6.33 ± 0.42^{a}	6.67 ± 0.57^{a}	7.33 ± 0.57^{a}	0.021
Texture	6.33 ± 0.57^{b}	7 ± 0.00^{ab}	7.33 ± 0.54^{a}	7.67 ± 0.46^{a}	0.055
Smell	8.66 ± 0.75^{a}	8.00 ± 0.00^{a}	8.33 ± 0.42^{a}	8.66 ± 0.37^{a}	0.363
Taste	6.33 ± 0.83^{b}	6.67 ± 0.36^{ab}	7.33 ± 0.31^{ab}	7.667 ± 0.45^{a}	0.077
Overall acceptability	5.33 ± 0.94^{c}	6.33 ± 0.57^{bc}	7.33 ± 0.96^{ab}	7.67 ± 0.23^{a}	0.004

Legends: Values in the same row with the same superscripts but different Means ± SD are not statistically significant ($P<0.05$).

4.1.7 Bacteriological quality of bean- barley baby food

The prepared bean- barley baby food overall bacteriological quality was found to be good (Table 4.6).

Table 4. 6 Relative bacteriological load of baby foods

Prepared food sample	Total Viable count (CFU/g)	Total Coliform count (CFU/g)
A	Less than 10	Nil
B	Less than 10	Nil
C	Less than 10	Nil

Legends: Values in the same column with the same superscripts but different Means ± SD are not statistically significant ($P<0.05$).

4.2 Formulated best one

Table (4.1- 4.6) above shows the proximate and mineral composition, vitamin A content, sensory evaluation results, and microbial content of three formulated baby foods (A, B, and C). In terms of proximate composition, sample C had higher levels of protein, fiber, fat, ash, and energy than the other two baby food formulations and the control.

The moisture content was lowest in sample A than in the other two samples. Though the moisture content of sample C was highest, the amount of moisture was safe enough for a long period of storage without spoilage. Depending on the environment, moisture content can change. As the protein, fat, ash, fiber and energy content of C was higher than the other two samples, these made it the best one.

In terms of mineral composition, sample C once more outperformed the other two samples. Regarding vitamin A content, Sample C received a higher score. The C formula had the highest overall acceptance rating out of the three formulated baby foods, receiving a score of 7.667 out of a possible 9. The C microbiological level was also within acceptable bounds. Total acceptance for the other two samples was less than C. Due to Sample C's superiority, it was decided that it should be the top sample.

4.3 Comparison of formulated best one (C) with locally available commercial foods:

4.3.1 Comparison of proximate compositions (mean ± SD) of formulated best one (C) with locally available baby foods

Table 4.7 compares the relative composition of the best formula (C) with the commercially available baby foods in the area. Here, the carbohydrate content of sample C was higher than the commercial products P1 and P2. Both commercial baby food products contain the same amount of protein, but Formulated C has the lowest protein content of all. Although the amount of fat in C and P2 was relatively close, the amount of fat in commercial food P1 was the highest. Additionally, the fiber content values in samples C and P1 were nearly identical.

Table 4. 7 Comparison of proximate compositions (mean ± SD) of formulated best one (C) with locally available baby foods

Parameters	Sample C	P1	P2	1-P value
Carbohydrate	73.26 ± 1.76^{a}	68 ± 3.61^{b}	65 ± 2.00^{b}	0.021
Protein	10.20 ± 0.20^{b}	15 ± 0.79^{a}	15 ± 1.32^{a}	0.001
Fat	8.23 ± 0.03^{b}	10 ± 0.65^{a}	9 ± 0.62^{ab}	0.017
Fiber	1.64 ± 0.03^{b}	2 ± 0.265^{b}	3.4 ± 0.36^{a}	0.000

Legends: Values in the same column with the same superscripts but different Means ± SD are not statistically significant ($P<0.05$)

4.3.2 Comparison of energy content of formulated best one (C) with locally available baby foods

Two commercial products' energy contents were compared to that of the best formulation (C).

Table 4. 8 Comparison of energy content of Sample C with commercial baby foods available in market.

Products	Energy content
Sample (C)	407.91
P1	422
P2	408

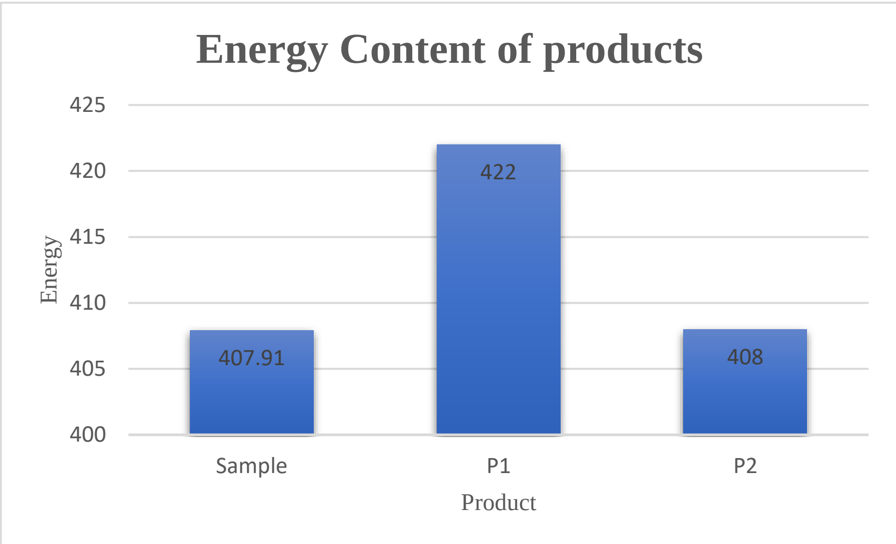


Figure 4. 2: Comparison of energy content of sample C with commercial baby foods available in market.

4.3.3 Comparison of minerals composition of formulated best one (C) with available commercial baby foods

Table 4.9 compares the mineral composition of the best baby food that was developed with the locally available commercial baby foods.

Table 4. 9: Comparison of minerals composition (mean ± SD) of formulated best one (C) with available commercial baby foods

Products	Calcium	Iron
Sample (C)	346 ± 25.2^{c}	$8.36 \pm 0.16^{\mathbf{b}}$
P1	450 ± 25.7^{b}	10 ± 0.624^{a}
P2	580 ± 23.3^{a}	8.8 ± 0.656^{b}

Legends: Values in the same column with the same superscripts but different Means ± SD are not statistically significant (P<0.05).

4.3.4 Comparison of vitamin A content of formulated best one (C) with locally available baby foods

Table 4.10 compares the vitamin A content of the locally accessible commercial baby foods with the baby food that was developed to be the best (C).

Table 4. 10 : Comparison of vitamin A content (mean ± SD) of formulated best one (C) with locally available baby foods

Products	Vitamin A
Sample (C)	334 ± 16.00^{a}
P1	360 ± 16.64^{a}
P2	330 ± 16.37^{a}

Legends: Values and Means ± SD are statistically significant (1-P Value 0.001).

4.4 Comparison of cost analysis of accepted baby food (Sample C) and commercial baby foods (P1, P2, P3)

When calculating the price of developed baby food, various costs, including the price of electricity, the cost of jars, and the cost of raw materials used in food preparation, were taken into account. The price of the prepared food as well as the market costs of two commercial baby foods were compared at the same time, as seen in Table 4.11.

Table 4. 11: Comparison of cost analysis of accepted baby food (Sample C) and commercial baby foods (P1, P2).

Heads	Tk./ Kg	Quantity used (g/ 100 g products)	Total (Tk)		
Expenditure Raw materials			Sample C	P1 (400 gm)	P2 (400 gm)
Bean	300	15	6.000		
Barley	320	35	6.400		
Almond	320	5	1.600		
Skim milk	540	14	7.560	-	-
Sugar	84	30	2.520		
Salt	35	1	1.000		
Sub total		100 gm	25.08	-	-
Processing cost @ 15% of raw material			3.762	-	-
Total cost of 100g baby food (Tk.)			28.842	-	-
*Price per packet (400g/packet)			115.368	350	385

Chapter 5: Discussion

5.1 Comparison among the mineral contents of raw kidney bean (black, white and red)

The mineral content of three different kinds of beans- black kidney beans, white kidney beans, and red kidney beans were analyzed in this study, and further research was designed and carried out based on the results of those analyses. Calcium, iron, and potassium are the three sorts of minerals that I focused on during my research; this is despite the fact that kidney beans contain other types of minerals. Table 4.1 shows that the red kidney bean contains a greater amount of all these three minerals.

5.1.1 Mineral content of raw beans

Table 4.1 presents the results of this experiment's mineral analysis on three distinct varieties of beans: black kidney beans, white kidney beans, and red kidney beans. These beans were tested for calcium, iron, and potassium. It was discovered that the red kidney bean had the highest levels of calcium (1016.73± 75.7%), iron (15.157±0.176%), and potassium (1546.7±40.4%) out of the three varieties of kidney beans. Calcium and iron concentrations are (1466±412%) and (55±8.3%) respectively, according to (Beebe et al., 2000). These results demonstrate that while the iron content of raw red kidney beans differs from the sample, the calcium content is largely comparable to the sample. (Moraghan and Grafton, 2001) asserts that B, Ca, Fe, K, Mg, Mn, N, P, and Zn concentrations in the seeds of various beans grown in various locations were influenced by both genotype and environment.

5.2 Comparison among the formulated best one with the others and control

5.2.1 Proximate composition

Table 4.2 lists the approximate composition of three prepared baby foods. Sample C of these three baby foods scored much higher than all of the other samples and the control in terms of the amount of protein, fat, fiber, and ash they contained. The moisture content of the formulated best baby food (sample C) had the lowest (5.3±0.3%) moisture than the others which are 6.78±0.03%, 6.61±0.04%, 6.12±0.015 shows the moisture content of control, sample A and sample B respectively. This finding suggests that sample C has a greater capacity for storage than the other samples. The moisture content of food and food items is essential because it extends the shelf life of the product by enhancing microbial breakdown activity, which prevents the product from developing the foulest odor and most offensive taste (Owolabi, 2007).

Protein is the second most important component of our bodies' tissues, following water. It is a nutrient that is essential for the process of growing. Protein and various other nitrogenous substances are continually broken down and remade within the body, which indicates that the organism is in a potential condition. Protein is used up at a rate that is more than what is typically taken in through diet on a daily basis in the body (Brown M. L., 1990). Proximate analysis of the developed products shows that the control and samples contain 5.69 ± 0.02%, 7.59 ± 0.05%, 9.70 ± 0.052% and 10.2 ± 0.2% protein in control, sample A, sample B and sample C respectively. This data shows the highest protein content in sample C.

Carbohydrates are necessary for children as a source of energy to fulfill the requirements of their daily needs. On the other hand, eating an excessive amount of carbohydrates might cause childhood obesity (Sartorius et al., 2018). Among all formulations sample C contains the lowest carbohydrate. Fat is a crucial component of cell membranes, and the human body need it for effective cell repercussion and the transportation of material inside the cells themselves. However, high levels of fat in humans have been connected with several cardiovascular diseases. Fat content of the control and samples are 7.77 ± 0.02%, 7.83 ± 0.05%, 7.98 ± 0.02% and 8.23 ± 0.035%. And sample C also hits higher for this parameter. Children with diets containing between 2.5 and 5.9 grams of crude fiber consumed a wider range of foods, more servings of each food, and tended to have diets that met or exceeded two-thirds of the RDA for all nutrients except for iron. These results were found in a study that was conducted on children (Endres et al., 1981). The crude fiber contents of the of three formulation and the commercial product were 1.06 ± 0.115%, 1.11 ± 0.015%, 1.37 ± 0.20% and 1.65 ± 0.035% respectively. Here sample C contains the highest amount of crude fiber which meets the range of Egyptian Organization for Standardization (Egyptian Standard, 2005). Ash content is an essential parameter that may be used to evaluate the authenticity of food products (Owolabi, 2007). The ash content sample C was highest than all other formulations and control. These findings indicated that the sample C baby food was adequate in nutrients for meeting the daily requirement.

5.2.2 Mineral content

The proximate composition of three prepared baby foods has been described in table 4.3. Among the three samples and the control all three minerals (calcium, iron and potassium) sample C showed the highest amount. The quantity of calcium, iron, potassium was 346 mg/100g, 8.53 mg/100g and 318 mg/100g respectively.

According to (FAO, 2001; FAO and WHO., 2019; Ronoh et al., 2017) the recommended dietary allowance (RDA) for calcium is 435.51 mg/100 g, the RDA for iron is 10 mg/day, and the RDA for potassium is 750 mg/day. Even though the mineral content of sample C does not completely meet the requirement, it did show significant differences when compared to the control and the other samples formulated with the same formula. This suggests that if the composition is modified, then it may possibly meet the daily requirement for minerals.

5.2.3 Vitamin content

Among the three samples and control sample C showed the best result among the others which corresponds to the (USDA, 2015) vitamin A content 400 mg/day.

5.2.4 Microbial content

The overall bacteriological status of both produced and imported commercial infant feeds was determined to be satisfactory (Table 4.6). According to the findings, both the total number of viable bacteria and the total coliform count in sample C were lower than 10 CFU/g.

5.2.5 Sensory evaluation

Sensory evaluation of the three formulations was deliberated one of the essential tests affecting, to large extent, their acceptability (Laila M., 1999). The results of a sensory evaluation of the three different baby foods and the sample are presented in Table 4.5 below. There were substantial changes in terms of look, taste, and general acceptability between the sample and the product containing all three different formulations. There was not a discernible change in either the texture or the odor of any of the two options. But in terms of the formulation's general acceptability, sample C was the clear winner over the other options.

5.3 Comparison of formulated best one (C) with locally available commercial foods

5.3.1 Proximate composition of prepared baby food compared with commercial baby foods

Table 4.7 illustrates comparison of nutrients found in sample C and the commercial baby foods by performing proximate analysis.

Sample C, as well as both of the locally commercially available items P1 and P2, contain a more manageable level of moisture. There is no standard for the amount of moisture that has been established for baby foods or follow-up foods in the Codex Alimentarius Standards (FAO and WHO., 2019). Depending on the type of food, the water activity and moisture content of the food must be kept below 10% and 0.60-0.65 percent, respectively, to prevent microbial growth (Fricker and Scambos, 2009). Fresh foods are particularly susceptible to the growth of microorganisms because they typically have a water activity of 0.99 or less. (James M. Jay, 2005).

When compared to samples P1 and P2, the fat content of sample C is marginally lower than that of those two samples. According to (FAO and WHO., 2019). the protein content should be (14.52- to 41.13%). Even the commercial products do not meet the daily requirement for fat.

The amount of protein in the formulated baby food C was (10.2 ± 0.2%) which was a little lower than the minimum percentage (14.52%) specified in Codex Alimentarius standards by (FAO and WHO., 2019). Though commercial baby foods show a greater amount of nutrients, sometimes they could not meet the daily requirement of babies.

5.3.2 Comparison of mineral content of prepared sample C with commercial baby foods

Calcium is an essential nutrient for the growth of teeth and bones in children, as well as for the normal function of the immune system, blood coagulation, and the development of nerves and muscles that are resistant to injury (Iii et al., 1991). The amount of calcium that was present in the baby food that had been made was 370.0 mg/100 g. However, the greatest calcium concentration that was identified in commercial baby food was 584 milligrams per one hundred grams. According to the Codex Alimentarius Standards, the amount of calcium included in baby foods should not be lower than 435.51 milligrams per one hundred grams of dry food. In accordance with this criterion, the minimum Ca concentration of 435.51 mg/100 g that is established in the Codex Alimentarius Standards (FAO and WHO., 2019) was exceeded in all imported commodities as well as processed baby food. This was the case for all of the products.

Sample C had an iron value of 8.53 mg/100 grams. Iron concentrations in the commercial items varied between 8.2 and 9.5 mg/100g. The World Health Organization (WHO) states that children between the ages of 3 and 5 years old have daily iron requirements of 9 mg/100gm (WHO, 2016).

5.3.3 Comparison of microbial content of best formulated baby food (C) with commercial baby foods

According to the findings, the total number of viable bacteria and the total coliform count in sample C were both lower than 10 CFU/g. Additionally, it was demonstrated that commercial samples from less than ten can be considered acceptable. The items that were analyzed had low numbers, indicating that the thermal procedure was sufficient, the raw materials were of high quality, and the food was produced under good conditions for various processing steps. Additionally, the low numbers indicated that the food was produced under favorable conditions for various processing steps.

5.3.4 Comparison of best formulated baby food (C) with commercial baby foods

Sample C performed the best out of the three different formulations and the control. When sample C was compared with commercial samples, it revealed that there were significant differences between the commercial and the three formulation products in terms of appearance, texture, smell, taste, and overall acceptability. These differences were found in all of the aforementioned characteristics. The three different formulations received the least amount of support. This might be because customers are accustomed to the commercial product (Ijarotimi and Steve, 2008) or it could be because during the manufacturing of the commercial product, flavoring, sweetening, and other sensory-enhancing compounds are added (Ijarotimi and Steve, 2008). It may be possible to make the formulation more palatable by modifying it with some kind of naturally occurring flavoring agent.

5.3.5 Comparison of cost analysis of best formulated baby food (C) with commercial baby foods

The cost of the baby food with the best formulation (C) in one hundred grams was 28.842 takas. To get an accurate price comparison, the amount of commercial baby food that was measured out to be 400 grams each package was used, and the price of the prepared meal was also determined to be 400 grams per package. When compared to the cost of commercial foods, the price of the baby food that has already been made is affordable, which is especially impressive when one considers Bangladesh's very low per capita income.

Chapter 6: Conclusion

The eating behaviors of teenagers and young adults, including both food preferences and routines, are excellent predictors of those developed in early childhood. The early years of a child's life are crucial for providing access to nutritious food. The primary objective of this research was to develop strategies for preparing food at low cost that still provide sufficient nutrients for young children. Beans are a great, cheap way to get a wide variety of nutrients, including protein, fiber, magnesium, potassium, B vitamins, resistant starch, and the more recently discovered phytonutrients. Products made from red kidney beans, which are high in plant protein, can be used to treat anemia and soothe allergies. Thus, beans came to be used in the preparation of baby foods. The mineral content of three types of kidney beans (red, black, and white) were calculated. The red kidney bean was chosen because it contained the most minerals. To find a suitable analog for commercial baby foods, three formulations and a control sample were created. The highest levels of protein, fat, carbohydrate, minerals, and vitamin A were found in formulation sample C. Sample C, the best-formulated baby food, was also put up against two products. Sample C did poorly in the proximate and sensory tests because it lacked the commercial products' distinctive ingredients and added flavoring. This research, however, shows that among all bean formulations, sample C performs the best. It is also very cost effective for those without the financial means to guarantee their nutritional needs. Therefore, the study concludes that, with some tweaks to the recipe, homemade food can compete nutritionally with store-bought options, helping to achieve the ultimate goal of improving children's growth and nutrition in Bangladesh.

Chapter 7: Recommendations and Future Perspectives

Many factors influence a child's growth and development, including genes, hormones, the autonomic nervous system, and nutrition. The first three factors are undeniably crucial for kids' brain growth, and good nutrition provides the building blocks for maximum brainpower. Getting enough to eat as an infant and a young child is essential for maturing into one's full potential. While this research does provide a solution to the problem at hand, there are still areas where improvement is needed.

1. This research suggests that the nutritional quality of baby food can be improved by adding different nutrient-dense natural foods.
2. Amino acid profile, vitamin C, and fat-soluble vitamins like D, E, and K should all be checked.
3. The food must be tasty and appealing, because children like to eat tasty food.
4. Using natural flavorings and sweeteners can be a great way to boost the nutritional value and taste of a product.
5. Baby food should be tested further in a rat bioassay procedure to determine its nutritional quality.

References

Akubor P. I., Isolokwu P. C., Ugbane O., and Onimawo, I. A. 2000. Proximate composition and functional properties of African breadfruit kernel and our blends. Food Research International. 33: 707–712.

Aparicio Fernandez X., Yousef, G. G., Loarca Pina, G., de Mejia, E., and Lila, M. A. 2005. Characterization of polyphenolics in the seed coat of black jamapa bean (*Phaseolus vulgaris L.*). Journal of Agricultural and Food Chemistry. 53(11): 4615–4622.

Audu S. S., and Aremu, M. O. 2011. Effect of processing on chemical composition of red kidney bean (*Phaseolus vulgaris L.*) flour. Pakistan Journal of Nutrition. 10(11): 1069–1075.

Beebe S., G. A. V., and R. J. 2000. Research on trace minerals in the common bean. Food and Nutrition Bulletin. 21(4): 387–391.

Brown M. L. 1990. Present knowledge in nutrition. International Life Science Institute-Nutrition Foundation.

Champ, M. M.J. 2002. Non-nutrient bioactive substances of pulses. British Journal of Nutrition. 88(S3): 307–319.

Chaudhary R., and Sharma S. 2013. Conventional nutrients and antioxidants in red kidney beans (*Phaseolus vulgaris L.*): an explorative and product development endeavour. Annals Food Science and Technology. 14(2): 275–285.

Chokshi D. 2007. Subchronic oral toxicity of a standardized white kidney bean (*Phaseolus vulgaris*) extract in rats. Food and Chemical Toxicology. 45(1): 32–40.

Choung M. G., Choi B. R., An Y. N., Chu Y. H., and Cho Y. S. 2003. Anthocyanin profile of korean cultivated kidney bean (*Phaseolus vulgaris L.*). Journal of Agricultural and Food Chemistry. 51(24): 7040–7043.

Clark J. L., Taylor C. G., and Zahradka P. 2021. Black beans and red kidney beans induce positive postprandial vascular responses in healthy adults: A pilot randomized cross-over study. Nutrition, Metabolism and Cardiovascular Diseases. 31(1): 216–226.

Copeland L., Blazek J., Salman H., and Tang M. C. 2009. Form and functionality of starch. Food Hydrocolloids. 23(6): 1527–1534.

Dewey K. G., and Adu-Afarwuah, S. 2008. Systematic review of the efficacy and effectiveness of complementary feeding interventions in developing countries. In Maternal and Child Nutrition. 4(1): 24–85.

Egyptian Standard. 2005. Processed cereal-based foods for infants and children. Cairo: Egyptian Organization for Standardization and Quality Control, Ministry of Industry.

Endres J., Gulley B., and Fisher C. E. 1981. Crude fiber and nutrients in the diets of preschoolers. Home Economics Research Journal. 9(4): 319–326.

FAO. (2001). Food and Nutrition Technical Report Series

FAO and WHO. 2019. FAO/WHO codex alimentarius commission procedural manual.

Ferguson E. L., and Darmon N. 2007. Traditional foods vs. manufactured baby foods.

Fricker H. A., and Scambos, T. 2009. Connected subglacial lake activity on lower Mercer and Whillans Ice Streams, West Antarctica. 2003-2008. Journal of Glaciology. 55(190): 303–315.

Gonzalez E., and Paredes Lapez, O. 1993. Hard-to-cook phenomenon in common beans- a review. In Critical Reviews in Food Science and Nutrition. 33(3): 227–286.

Hayat I., Ahmad A., Ahmed A., Khalil S., Gulfraz M., and Kashmir A. 2014. Exploring the potential of red kidney beans (P*haseolus vulgaris L*.) To develop protein-based product for food applications. The Journal of Animal & Plant Sciences. 24(3), 860–868.

Haydé V. C., Ramón G. G., Lorenzo G. O., Dave O. B., Rosalía R. C., Paul W., and Guadalupe L. P. 2012. Non-digestible fraction of beans (*Phaseolus vulgaris L.*) modulates signalling pathway genes at an early stage of colon cancer in Sprague-Dawley rats. British Journal of Nutrition.

Iii H. L., Smith D. P., Whitney, M., Malicki D. M., Dolph P. J., Smith G. F. H., Burkhart W., and Zuker C. S. 1991. Isolation of a novel visual system specific arrestin: an in vivo substrate for light-dependent phosphorylation. In Mechanisms of Development. 33.

Ijarotimi and Steve. 2008. Protein and hematological evaluations of infant formulated from cooking banana fruits (*Musa spp*, ABB genome) and fermented bambara groundnut (*Vigna subterranean L. Verdc*) seeds. In Nutrition Research and Practice. 2(3).

Ikechukwu P. A. 2017. Comparative study on the proximate composition, functional and sensory properties of three varieties of beans- *Phaseolus lunatus*, *Phaseolus vulgaris* and *Vigna umbellata*. In International Journal of Advancement in Engineering Technology.

James M. Jay, M. J. L. D. A. G. 2005. Modern Food Microbiology.

Jiang L., Wang J., Li Y., Wang Z., Liang J., Wang R., Chen Y., Ma W., Qi B., and Zhang M. 2014. Effects of ultrasound on the structure and physical properties of black bean protein isolates. Food Research International. 62: 595–601.

Laila M., T. 1999. The preparation of some highly nutritive, low-cost baby food formulas. 241–251.

Lee I. H., Hung Y. H., and Chou C. C. 2008. Solid-state fermentation with fungi to enhance the antioxidative activity, total phenolic and anthocyanin contents of black bean. International Journal of Food Microbiology, 121(2), 150–156.

Liener I. E. 1994. Implications Of Antinutritional Components in Soybean Foods. Critical Reviews in Food Science and Nutrition, 34(1), 31–67.

M. Sisay Fikru, L. M. U. and G. A. 2014. Effects of replacing soybean meal with processed kidney bean meal (*Phaseolus vulgaris*) on egg production of white leghorn hens. World Applied Sciences Journal. 32(9), 1918–1926.

Margier M., Georgé S., Hafnaoui N., Remond D., Nowicki M., du Chaffaut L., Amiot M. J., and Reboul E. 2018. Nutritional composition and bioactive content of legumes: Characterization of pulses frequently consumed in France and effect of the cooking method. Nutrients, 10(11).

Martínez Zavala, M., Mora Avilés M. A., Anaya Loyola M. A., Guzmán-Maldonado H., Aguilera Barreyro A., Blanco Labra A., ana García Gasca, T. 2016. Common bean leaves as a source of dietary iron: functional test in an iron-deficient rat model. Plant Foods for Human Nutrition. 71(3): 259–264.

Metwalli O. M., Al-Okbi S. Y., and Abbas A. E. 1993. Impact of some commonly used Egyptian diets on plasma lipids profiles of rats. 32(3): 229–236.

Moraghan J. T., and Grafton K. 2001. Genetic diversity and mineral composition of common bean seed. Journal of the Science of Food and Agriculture, 404–408.

Mulambu J, A. and S. N. 2017. Chapter 10 iron beans in Rwanda: crop development and delivery experience.

Mundi S., and Aluko R. E. 2012. Physicochemical and functional properties of kidney bean albumin and globulin protein fractions. Food Research International. 48(1): 299–306.

N Qayyum, M. M., Butt M. S., Anjum F. M., and Nawaz H. 2012. Composition analysis of some selected legumes for protein isolates recovery. The Journal of Animal & Plant Sciences. 22(4): 1156–1162.

Ngobese N. Z., Wokadala O. C., Plessis B., Du da Silva L. S., Hall A., Lepule S. P., Penter M., Ngcobo M. E. K., and Swart H. C. 2018. Physicochemical and morphological properties of a small granule legume starch with atypical properties from wild mango (*Cordyla africana L.*) Seeds: A Comparison to Maize, Pea, and Kidney Bean Starch. 70(11–12).

O Romero Arenas, MA Damián Huato JA Rivera Tapia, A Báez Simón, M Huerta Lara, and E Cabrera Huerta. 2013. The nutritional value of beans (*Phaseolus vulgaris L.*) and its importance for feeding of rural communities in Puebla, Mexico. International Research Journal of Biological Sciences. 2(8): 59–65.

Osorio Díaz P., Bello Pérez L. A., Sáyago Ayerdi, S. G., Benítez Reyes M. D. P., Tovar J., and Paredes López O. 2003. Effect of processing and storage time on in vitro digestibility and resistant starch content of two bean (*Phaseolus vulgaris L*) varieties. Journal of the Science of Food and Agriculture. 83(12): 1283–1288.

Owolabi F. 2007. Proximate and elemental composition and their estimated daily intake in infant formulae from developed and developing countries: A comparative analysis. Journal of Food. Agriculture and Environment. 5 (2): 40–44.

Punia S., Dhull S. B., Sandhu K. S., Kaur M., and Purewal, S. S. 2020. Kidney bean (*Phaseolus vulgaris*) starch: A review. In Legume Science. 2(3).

Rehman Z. ur, Salariya A. M., and Zafar S. I. 2001. Effect of processing on available carbohydrate content and starch digestibility of kidney beans (*Phaseolus vulgaris L.*). Food Chemistry. 73(3), 351–355.

Ronoh A. K., Mercy Were G., Wakhu Wamunga F., and Wamunga J. B. 2017. Food Consumption Patterns among Pre-School Children 3 - 5 Years Old in Mateka. Western Kenya. Food and Nutrition Sciences. 08(08): 801–811.

Sartorius K., Sartorius B., Madiba T. E., and Stefan C. 2018. Does high-carbohydrate intake lead to increased risk of obesity? A systematic review and meta-analysis.

Shi J., Xue, S. J., Kakuda Y., Ilic S., and Kim D. 2007. Isolation and characterization of lectins from kidney beans (*Phaseolus vulgaris*). Process Biochemistry. 42(10): 1436–1442.

Takahashi R., Ohmori R., Kiyose C., Momiyama Y., Ohsuzu F., and Kondo K. 2005. Antioxidant activities of black and yellow soybeans against low density lipoprotein oxidation. Journal of Agricultural and Food Chemistry. 53(11): 4578–4582.

Takeoka G. R., Dao L. T., Full G. H., Wong R. Y., Harden L. A., Edwards R. H., De, J., and Berrios J. 1997. Characterization of black bean (*Phaseolus vulgaris L.)* Anthocyanins. Journal of Agricultural and Food Chemistry, 3395–3400.

Tang C. H., Sun X., and Yin S. W. 2009. Physicochemical, functional and structural properties of vicilin-rich protein isolates from three Phaseolus legumes: Effect of heat treatment. Food Hydrocolloids. 23(7), 1771–1778.

Tormo M. A., Gil Exojo I., Romero de Tejada A., and Campillo J. E. 2006. White bean amylase inhibitor administered orally reduces glycaemia in type 2 diabetic rats. The British Journal of Nutrition. 96(3): 539–544.

Tsuda T., Ohshima K., Kawakishi S., and Osawa'pt T. 1994. Antioxidative pigments isolated from the seeds of phaseolus vulgaris l. Journal of Agricultural and Food Chemistry. 42.

USDA. 2015. Nutritional goals for each age or sex group used in assessing adequacy of USDA Food Patterns at various calorie levels.

Wani I. A., Sogi D. S., Wani A. A., Gill B. S., and Shivhare, U. S. 2010. Physico-chemical properties of starches from Indian kidney bean (*Phaseolus vulgaris*) cultivars. International Journal of Food Science and Technology. 45(10): 2176–2185.

WHO. 2016. Guideline Daily Iron Supplementation in Infants and Children - World Health Organization - Google Books.

World Health Organization. 1998. Complementary feeding of young children in developing countries- a review of current scientific knowledge. The american journal of clinical nutrition. 71(2): 605–606.

Wu X., Beecher G. R., Holden J. M., Haytowitz D. B., Gebhardt S. E., and Prior R. L. 2004. Lipophilic and hydrophilic antioxidant capacities of common foods in the United States. Journal of Agricultural and Food Chemistry. 52(12): 4026–4037.

Yin S. W., Tang C. H., Wen Q. B., and Yang X. Q. 2010. Functional and conformational properties of phaseolin (*Phaseolus vulgris L.*) and kidney bean protein isolate: A comparative study. Journal of the Science of Food and Agriculture. 90(4): 599–607.

Yoshida H., Nozaki K., Hanashiro I., Yagi F., Ito H., Honma, M., Matsui H., Takeda Y., and Takeda Y. 2003. Structure and physicochemical properties of starches from kidney bean seeds at immature, premature and mature stages of development. In Carbohydrate Research. 338.

Zhang J., Shi J., Ilic S., Jun Xue S., and Kakuda Y. 2009. Biological properties and characterization of lectin from red kidney bean (*Phaseolus vulgaris*). Food Reviews International. 25(1): 12–27.

Appendices

Appendix A: Questionnaire for hedonic test of Bean- barley baby food.

Education level:

Date:

(a) Bachelor's degree (b) Master's degree

Sample code:

(c) other specify………………..

Instruction: You are given four samples. Please start your evaluation from left to right. Evaluate each attribute by circling the appropriate scale which indicates your degree of liking. Rinse your mouth with plain water before testing each sample.

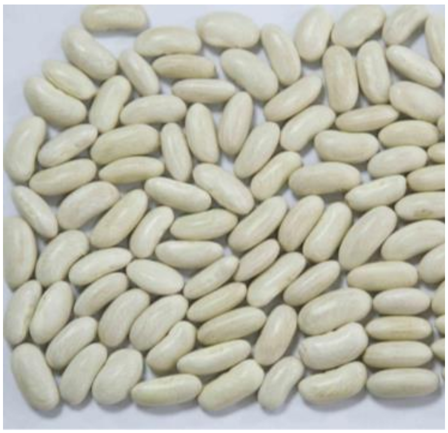
9- Like extremely, 8- Like very much, 7- Like, 6- Like slightly, 5- Neither like nor dislike, 4- Dislike slightly, 3- Dislike moderately, 2- Dislike, 1-Dislike extremely.

Attributes	9 Like Extremely	8 Like very much	7 Like	6 Like slightly	5 Neither like nor dislike	4 Dislike slightly	3 Dislike moderately	2 Dislike	1 Dislike extremely
Appearance									
Texture									
Smell									
Taste									
Overall acceptability									

Comment (if):

Appendix B: Photo Gallery

Red kidney bean



White kidney bean

Black kidney bean

Steaming red kidney bean

Drying red kidney bean

Grinding red kidney bean

Sieving red kidney bean

Red kidney bean powder

Roasting almond

Almond bean powder

Formulated products and control

Ash content

Fat determination

Mineral content

Protein determination

Microbial analysis

Microbial analysis

Microbial analysis

Sensory evaluation

Sensory evaluation

Brief biography

Susmita Saha passed the Secondary School Certificate Examination in 2012 from Rangunia Majumderkhill High School, and then Higher Secondary Certificate Examination in 2014 from Kapasgola City Corporation Mohila College, Chattogram. She obtained her B.Sc. (Honors) in Food Science and Technology from the Faculty of Food Science and Technology at Chattogram Veterinary and Animal Sciences University, Chattogram, 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, Chattogram Veterinary and Animal Sciences University (CVASU). She has an immense interest in working in improving the health status of people through proper guidance and suggestions and to create awareness among people about food safety and nutrition.