COMPARATIVE STUDY ON QUALITY (NUTRITIVE, PHYSICO-CHEMICAL AND MICROBIAL) OF PREPARED AND COMMERCIAL MALTED MILK HOT DRINKS IN BANGLADESH

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Roll No: 0115/05

Registration No: 0276

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A thesis submitted in the partial fulfillment of the requirements for the degree of Master of Science in Food Processing and Engineering

Department of Food Processing and Engineering
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December 2016

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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 2016

Dedication

I dedicate this small piece of work to my beloved Family

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The Author

List of abbreviation

Abbreviation	Elaboration
%	Percentage
°C	Degree centigrade
µm	Micrometer
BARI	Bangladesh Agriculture and Research Institute
BGA	Brilliant Green Agar
BPA	Buffered Peptone water
CVASU	Chittagong Veterinary and Animal Sciences University
d	Day
DMRT	Duncan's Multiple Range Test
G	Gram
INS	International Numbering System
Kcal	Kilo Calorie
Kg	Kilogram
L	Litre
min	Minutes
ml	Milliliter
MSA	Mannitol Salt Agar
N	Normality
p	Probability
PRTC	Poultry Research and Training Center
r	Correlation coefficient
Tk	Taka
UK	United Kingdom
Vol	Volume
Wt	Weight
XLD	Xylose Lysine Deoxycholate
y	Year

Abstract

The study was conducted on the development of the new product, malted milk hot drinks recognized as sample A where barley is the key ingredients. The developed product was compared with the four samples recognized as Sample B, sample C, sample D and sample E that available in the local market as malted milk hot drinks. These samples were analyzed for their proximate, bacteriological and sensory qualities using standard methods. Moisture, Protein, Fat, Carbohydrate, Ash and Energy content was found 9.18%, 11.23%, 4.90%, 71.57%, 3.10% and 385.14 Kcal/100g, which was able to meet the young children's recommended daily allowances. The protein content of the developed product was very high (11.23) than any other samples. The acceptability of the samples was studied by a taste panel consisting of 15 panelists. There was no significant difference ($p<0.05$) in terms of the texture and overall acceptability of the samples as powder, among them Sample C (7.87) got the highest acceptability. All the samples were liked very much in terms of overall acceptability as drinks. The developed product had highly acceptable sensory values even without any addition of either of natural or artificial colour and flavour; whereas the commercial products use. The bacteriological analysis was done to see the acceptability of the products and the result was good from the bacteriological point of view; since there was no growth of investigated bacteria. The developed product was very cheap approximately 200Tk/Kg and 4 times lower than the commercial products, along with it provides more servings than others. Therefore, the product may boost us to maintain a healthier life at a cheap rate and help to alleviate malnutrition situation in Bangladesh.

Keywords: Malted Milk Hot drinks, Nutritional quality, Bacteriological and Sensory qualities.

Chapter-01: Introduction

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).

Although recent progress has been made in reducing the incidence of poverty, malnutrition still remains one of the most serious problems in Bangladesh and responsible, directly or indirectly, for about one half of the 343,000 deaths that occur annually among children under five years in Bangladesh. About three-quarters of these deaths, which are often associated with inappropriate feeding practices, occur during the first year of life. Most children between the age 4 months and 2 to 3 years suffer from malnutrition. The reasons behind this fact are generally low incomes, poor sentimental conditions and lack of education (BDHS, 2007 and General Economic Division, Planning Commission, GOB, 2007).

Changing lifestyles, potential nutritional and therapeutic benefits and also technological innovations in the processing and packaging of beverages have led to significant growth in the beverage segment of the food industry. Malted milk food is one such product that has cornered a sizeable market of such beverages. India has emerged as the biggest market for malted milk-based food formulations (Singh et al., 2008). Malted milk foods in India have registered a growth rate of 5% to 8% over the last 10 years (Dhillon, 2005). The Ministry of Food Processing Industries, Government of India, estimated in 2001–02 that the total production of malted milk food in the country was about 68000 metric tons (MOFPI 2002).

In the first 1000 days of a child's life, poor nutrition can lead to irreversible stunted growth, which associated with reduced school and impaired cognitive ability and work performance (Hoque et al., 2016).Malnutrition, which affecting the health,

nutritional status and school academic performance, is suffered by a significant percentage of school age children in Bangladesh (Yeasmin and Islam, 2016).

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). Flavored milk can increase milk consumption among both adults and children and also provides essential nutrients like plain milk and other milk products (Murphy et al., 2008). Flavored milk consumers had almost 150 kcal more energy intake compared to nonconsumers (Li and Drake, 2015). Noel et al., (2013) reported that over a 2-y period, overweight children that were flavored milk consumers had less favorable changes in body fat and body weight. They suggested that overweight children should reduce consumption of flavored milk; however, they also noted that consumption of flavored milk was unlikely to be associated with body fat or weight gain for normal weight children.

Malting has been shown to be one of the most effective and convenient ways for improvement of nutritional value of cereals (Adeyemo et al.,1992; Akpapunam et al.,1996; Gernah et al.,2011); and currently there is a growing interest 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).

In our local market there are four brands are found as malted milk hot drinks manufactured by the multinational company but there is still lack of local industries. Some malted milk hot drinks are also found of these companies as imported. The price of these products is so high and is not within the reach of rural dwellers and low income earners in the urban cities. In recent years, consumers have become more health conscious in their food choices but have less time to prepare healthful meals. As a result the market demand for “minimally processed” or “lightly processed” foods has rapidly increased (Parvin et al., 2014).

Therefore, the present study was undertaken to develop a cereal based highly nutritive supplementary food for young children of Bangladesh with a low price by using available resources and cheap technology.

1.1 Objectives

I. To develop a protein and energy enriched malted milk hot drinks for the people of Bangladesh.

II. To compare the quality (nutritional, physico-chemical and microbial) of the product with the commercially available malted milk hot drinks in local market of Bangladesh.

III. To analyze organoleptic acceptability of the developed products.

1.2 Anticipated outcomes

I. Developed protein and energy enriched malted milk hot drinks for the people of Bangladesh.

II. Identified the quality (nutritional, physico-chemical and microbial) of the product with the commercially available malted milk hot drinks in local market of Bangladesh.

III. Estimated organoleptic acceptability of the developed products.

Chapter-02: Review of Literature

According to FAO (2002), plants and cereal grains provide nearly 70% of food proteins and more than 80% of food energy requirements.

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)

Singh et al., (2008) reported that changing lifestyles, potential nutritional and therapeutic benefits and also technological innovations in the processing and packaging of beverages have led to significant growth in the beverage segment of the food industry. Malted milk food is one such product that has cornered a sizeable market of such beverages. The use of malt in milk-based beverage formulations offers new opportunities for the dairy industry. Malted barley as the key ingredient of such malt-milk beverages will add not only delectable taste, colour and sweetness, but also many functional attributes, to the product.

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.

Rahman and Hakim (2016) reported that each year about 13 million infants and children die in developing countries and most of these deaths can be related to malnutrition. Malnutrition is the biggest single contributor to child mortality in the developing countries. About four of each five malnourished children live in South East-Asia (SEA) region and it is now recognized that nearly 83 percent of child deaths are attributable to mild to moderate malnutrition. Childhood malnutrition leads to stunted growth and increased morbidity and mortality and it also decreases the survival chances of adults later in life and Psychological and intellectual development. The major etiological factors contributing to protein calorie malnutrition in different countries of South–East Asia are similar and may be considered to fall under the following heads: 1) Lack of calories and protein rich food for the feeding of infants and children due to socio-economic and agronomical factors. 2) Faulty-feeding habits arising from ignorance prejudices and superstitions. 3) Poor environmental condition leading to superimposition of additional stress in the natures of infections and infestations.

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.

Protein energy malnutrition and micronutrient under nutrition occur together. Millions of children and women suffer from one or more forms of malnutrition including low birth weight, wasting, stunting, underweight, Vitamin A deficiencies, iodine deficiency disorders and anemia. Although recent progress has been made in reducing the incidence of poverty, malnutrition still remains one of the most serious problems in Bangladesh and responsible, directly or indirectly, for about one half of the 343,000 deaths that occur annually among children under five years in Bangladesh. About three-quarters of these deaths, which are often associated with inappropriate feeding practices, occur during the first year of life. Most children between the age 4 months and 2 to 3 years suffer from malnutrition. The reasons behind this fact are generally low incomes, poor sentimental conditions and lack of education (BDHS, 2007 and General Economic Division, Planning Commission, GOB, 2007).

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).

Li and Drake (2015) reported that bone health in children and adolescents is related to the intake of milk and milk products. Milk and milk products contain numerous essential nutrients such as omega-3 fatty acids ,short and medium chain fatty acids, vitamins (A, E, B12), minerals (that is, calcium, magnesium, zinc, and so on), and bioactive compounds (Haug et al., 2007). Quann and Adams (2013) also confirmed that the consumption of dairy falls short for children based on the recommended daily consumption suggestions of Dietary Guidelines for Americans (3 servings/d of fat-free or low-fat milk or equivalent milk for adults and children ages 9 to 18 y, 2.5 servings/d for children ages 4 to 8 y, and 2 servings/d for children ages 2 to 3 y). For

adults>20 y, the percentages of fluid milk consumed decreased significantly between 1977 to 1978 and 2005 to 2006. Furthermore, the fluid milk consumption frequency decreased for adolescents and adults from 1977 to 1978 to 2007 to2008. Consumers who drank milk 3 or more times per day decreased from 13% to 4% and consumers who did not drink fluid milk on a given day increased from 41% to 54% (Stewart et al., 2013).

Li and Drake (2015) also reported that Sir Hans Sloane, a British physician, was believed to 1st invent chocolate milk by mixing cocoa with milk to make the drink more palatable when he was introduced to cocoa as a local favorite drink in Jamaica in the late 1600s, and it was 1st sold as a medicine in England. In modern America, flavored milk and milk drinks are milk-based drinks with caloric additions such as chocolate- and fruit-flavored milk, milk shakes, hot chocolate/cocoa, malted milk, lattes and similar coffee beverages, and eggnog. In 2011, there were 2.09 billion kg sales in flavored milk and milk drinks, which decreased by 2.8% compared to 2010 (Intl. Dairy Foods Assn. 2011). Among the different flavors of flavored milk (for example, chocolate, strawberry, and vanilla), chocolate milk is the most popular milk flavor for both children and adults in the United States (Boor 2001; Thompson et al., 2004; Thompson et al., 2007; NDC, 2010).

Flavored milk provides the same 9 essential nutrients as plain milk (unflavored): protein, calcium, potassium, phosphorus, vitamins A, D, and B12, riboflavin, and niacin (NDC, 2011). Flavored milk can improve dairy consumption and lower the intake of soft drinks and fruit drinks, and increase calcium intake (Johnson et al., 2002). Flavored milk consumers also had higher calcium intake. However, flavored milk consumers had almost 150 kcal more energy intake compared to nonconsumers. Noel et al., (2013) reported that over a 2-y period, overweight children that were flavored milk consumers had less favorable changes in body fat and body weight. They suggested that overweight children should reduce consumption of flavored milk; however, they also noted that consumption of flavored milk was unlikely to be associated with body fat or weight gain for normal weight children.

Parvin et al., (2014) also compared the supplementary baby food prepared in the laboratory with the commercial baby foods available in Bangladesh. The carbohydrates content of the formulated baby food was 74.39g/100g, whereas

cerelac1 contains 67.75 g/100g and cerelac 2 contain 71.7g/100g.So the formulated food had higher carbohydrate content than cerelac and supply 71.32% recommended carbohydrate for infant. The protein content (g/100 g dry weight) in the formulated food was 11.91 g/100g. The high content of protein in the commercial foods Cerelac-1 was 15g/100g and cerelac-2 was 12.5g/100g. The ash content of the product gives an idea of the mineral content, although formulated baby food had low ash contents (1.88g/100g) than the commercial baby food (cerelac-1 contains 2.45g/100g and cerelac-2 contains 3.2 g/100g).The energy content of the formulated weaning foods was 433.9 kcal/100 g. For the commercial baby food such as Cerelac-1 and Cerelac-2, the energy densities were 421 and 418 kcal/100g respectively. The RDA of energy for infant is 880kcal/day (IOM, 2005). The energy densities observed in this study for formulated baby food was slightly high than commercial baby foods and supply 58.27% calorie of RDA to meet the energy needs of the infant.

Chapter-03: Materials and Methods

The experiment was conducted in the laboratory of the department of food processing and engineering, Chittagong Veterinary and Animal Sciences University (CVASU).

3.1 Preparation of malted milk hot drinks

3.1.1 Collection of raw materials

Eight ingredients were used for the preparation of malted milk hot drinks. The main ingredient barley was collected from Bangladesh Agriculture and Research Institute (BARI). The other good quality commercial ingredients such as wheat flour, sugar, skim milk powder, egg, INS 500 (ii), cocoa powder and salt were collected from local market of Chittagong city.

3.1.2 Processing of the raw materials:

3.1.2.1 Barley:

The barley was cleaned and ground into a fine powder of 500-600 μm in a grinder and passed through 20 mesh size. The fine powder of barley was then collected in an air tight container and stored at room temperature in a dry place.

3.1.2.2 Egg yolk powder:

At first the egg yolk was separated from the egg white. Then it was dried in the hot air oven for 24 hours at 105^0C temperature. After that it was ground into find powder in a grinder and passed through 20 mesh size. The fine egg yolk powder was then collected and stored.

3.1.3 Formulation of the product:

After several trials a formula was developed. The formulation of the malted milk hot drinks is given in Table- 3.1

All ingredients were taken in a bowl, and mixed by the spoon. Then it was taken into a blender for homogenous mixing. After mixing it was collected and stored.

3.2 Sample collection

Four commercial malted milk hot drinks were available in the local market and those were collected to compare with the prepared malted milk hot drinks. Sample A is the laboratory prepared and the sample B, sample C, sample D and sample E are the commercial samples respectively.

Table 3.1: Formula of the prepared malted milk hot drinks

Ingredients	Percentage (%)
Barley	38
Wheat Flour	27
Sugar	13
Skim milk powder	14
Egg yolk powder	0.5
INS 500 (ii)	0.5
Cocoa powder	6.5
Salt	0.5
Total=	100

3.3 Proximate analysis

The five samples were analyzed for moisture content, ash content, crude protein, crude fat and total carbohydrate. All the determinations were done in triplicate and the result were expressed as the average value.

3.3.1 Moisture content

Moisture content was determined adopting AOAC (2005) method 14.004.

Procedure

About 5g was taken in a pre-weight crucible (provide with cover) which was previously heated to 130^0C. The sample was dried for 1 hour in an air oven maintained at temperature 130 ± 3^0C. The crucible was while still in oven then transferred to desiccator and weighed immediately after reaching at room

temperature. The loss of weight from sample was determined and the percent of moisture was calculated as follows:

$$\% \text{ Moisture content} = \frac{\text{Loss in weight}}{\text{Weight of sample}} \times 100$$

3.3.2 Ash

AOAC method 14.006 (2005) was used to determine the total ash content.

Procedure

A 5gm sample was weighed into clean, dry porcelain ashing dish which burned until white smoking stopped. The sample was then ignited with a gas burner until white smoking stopped. The sample was then placed in a muffle furnace at 550^0C and ignited until light gray ash resulted (or to constant weight). The sample was then cooled in desiccators and weighed. The ash content was calculated by the following expression:

$$\% \text{ Ash} = \frac{\text{Loss in weight}}{\text{Weight of sample}} \times 100$$

3.3.3 Protein

Protein content was determined using AOAC (2005) method 2.049. The method was as follows:

Reagent required

i) Concentrated sulphuric acid (nitrogen free)

ii) Digestion mixture
Potassium sulphate =100gm
Copper sulphate = 10 g
Selenium di-oxide = 2.5g well mixed in mortar and kept in a dry place.

iii) Boric acid solution = 2% solution in water

iv) Alkali solution = 400g sodium hydroxide in water and dilute to 1 litre.

v) Mixed indicator solution: Bromocresol= 0.1g and methyl red= 2g dissolved in 250 ml ethyl alcohol

vi) Standard HCl : 0.1 N

Procedure

A 5g digestion mixture was weighed accurately and transferred into a dry 300ml Kjeldahl flask. A suitable quantity of the sample (1g for each) was transferred into the flask. 20ml of sulphuric acid was added, heated continuously until frothing ceased and then simmered briskly. The solution became clear in 15-20 min., continued heating for 45 min. After cooling, 100ml water was added, and transferred quantitatively to a 1 litre round- bottom flask; the final volume was about 500 ml. Added gently sown the side enough sodium hydroxide solution to form a participate of cupric hydroxide and immediately connected the flask to steam-trap and condenser. Then 50ml of boric acid solution, 50ml distilled water and 5 drops of indicator solution were added to a 500ml conical receiving flask. Positioning the condenser distillation was carried out for 4 to 5 minutes or until about 250 ml of distillate was attained, the contents of the receiving flask were titrated with 0.1 N hydrochloric acid, the end point was marked by a brown color. A reagent blank as also determined and deducted from the titration. One milliliter of 0.1N hydrochloric acid is equivalent to 1 mg of nitrogen. A protein conversation factor was to calculate the percent protein from nitrogen determination. Percentage of nitrogen and protein calculated by the following equation:

$$\% N_2 = \frac{(T_s - T_b) \times \text{N of HCL} \times 14 \times \text{Vol. made up the digest} \times 100}{\text{Wt. of sample (gm)} \times \text{Aliquot of the digest taken} \times 100}$$

Where,

T_s = Titre volume of the sample (ml)

T_b = Titre volume of the blank (ml)

% Protein = % Nitrogen × Protein factor

3.3.4 Crude Fat

AOAC (2005) method using Soxhlet apparatus was used to determine crude fat content of the samples.

Procedure

The dried sample was transferred to a thimble and plugged the top of the thimble with a wood of fat free cotton. The thimble was dropped into the fat extraction tube attached to a Soxhlet apparatus. Approximately 75ml or more of anhydrous petroleum

ether was poured through the sample in the tube into the flask. Top of the fat extraction tube was attached to the condenser. The sample was extracted for 16 hours or longer on a water bath at 70-80^0 C.

At the end of extraction period, the thimble from the apparatus was removed and distilled of the petroleum ether by allowing it or collected in Soxhlet tube. The petroleum ether by allowing it or collected in Soxhlet tube. When the petroleum had reached small, it was purer into a small, dry (previously weighed) beaker through a small funnel containing plug cotton. The flask was rinsed and filtered thoroughly using petroleum ether. The petroleum ether was evaporated on steam bath at low temperature and was then dried at 100^{0}C for 1 hour, cooled and weighed. The difference in the weight gave the ether soluble materials present in the sample. The percent of crude fat was expressed as follows:

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

3.3.5 Total carbohydrate

Total carbohydrate content of the sample was determined as total carbohydrate by difference, that is by subtracting the measured protein, fat, ash and moisture from 100 (Pearson, 1970).

3.3.6 Energy content

The energy content of the baby food samples was determined by calculating the amount of protein, fat and carbohydrate of respective food items and by using the following equation (Parvin et al., 2014).

Energy = (Protein × 4.1) + (Fat × 9.3) + (Carbohydrate × 4.1).

3.4 Sensory evaluation

A taste-testing panel evaluated the consumer's acceptability of developed product and the commercial collected samples. The panelists were selected from the students, teachers and employees of the Chittagong Veterinary and Animal Sciences University. The panelists (15) were requested to assign appropriate score for characteristics of appearance, colour, flavor, texture and overall acceptability of malted milk hot drinks powder and the characteristics of appearance, colour, flavor,

consistency and overall acceptability of malted milk hot drinks. They were served with 45-50 ml of the malted milk hot drinks prepared as the instruction (135g/L for sample B, 135g/L for sample C, 100g/L for sample D and 180g/L for sample E respectively) given by the manufacturer of the samples B, C, D and E. The sample A was prepared by adding 80 g powder with one litre milk. Each sample was prepared with milk and 30 g sugar was added with one litre milk for taste.

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. This method does not, of course, reflect actual consumer perception, but it does strongly indicate attributes which a good quality product should possess (Sing et al., 2008). All analyses were carried out in duplicate for each sample and results obtained were computed into means. The results were evaluated by Analysis of Variance and Duncan's New Multiple range Test procedures of the Statistically Analysis System (SAS, 1985).

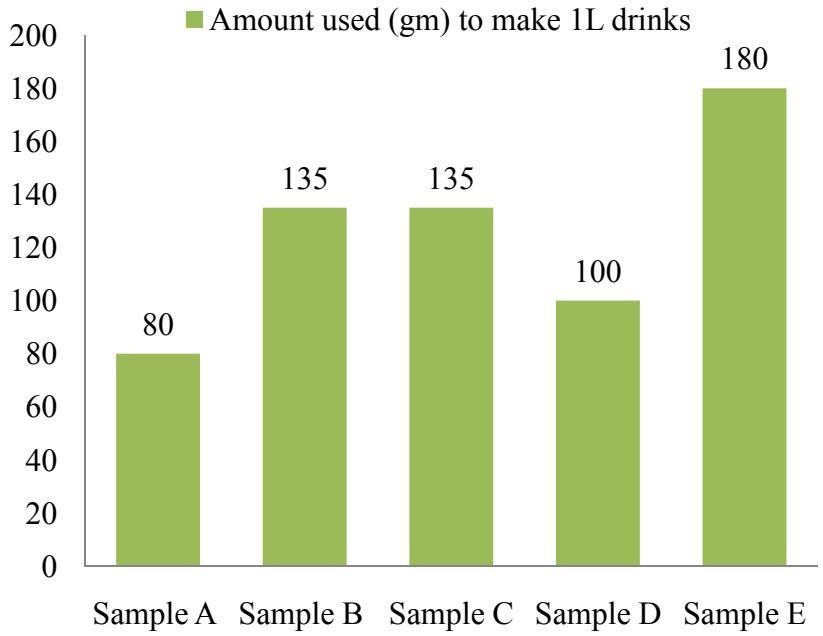

Figure 3.1: Amount of malted milk hot drinks powder to make 1 L drinks

3.5 Bacteriological Investigation

The bacteriological investigation of the samples was done in the Poultry Research and Training Centre (PRTC), Chittagong Veterinary and Animal Sciences University, six

months later the product had developed in the laboratory to get an idea about the shelf life of the products.

3.5.1 Isolation and identification of *Staphylococcus sp*

The samples were placed into sterile Buffered Peptone Water (BPA) (Oxoid ltd, Basingstoke, Hampshire, UK) and enriched for 24 hours at 37 °C (Thaker et al., 2013). Both Mannitol salt agar medium and Blood agar base were prepared per the instructions of manufacturer (Oxoid ltd, Basingstoke, Hampshire, UK). Blood agar was prepared by adding 5% citrated-bovine blood in the blood agar base. A loopful of inoculum from enrichment were streaked on Blood Agar (Oxoid ltd, Basingstoke, Hampshire, UK) and incubated at 37°C for 24 hours for detection of hemolysis. Growth of yellow colonies on MSA (Oxoid ltd, Basingstoke, Hampshire, UK) surrounded by yellow zones as a result of fermentation of mannitol after 24 hours of incubation at 37°C indicated a positive result (Kateete et al., 2010).

3.5.2 Isolation of *Escherichia coli*

Pre-enrichment of *E. coli* were done in BPA broth (Oxoid ltd, Basingstoke, Hampshire, UK) of the samples (Thaker et al., 2013). A loopful of culture inoculates on MacConkey (Oxoid ltd, Basingstoke, Hampshire, UK) agar. Pink colonies obtained from MacConkey agar were taken and inoculated on Eosin methelene blue (EMB) (Oxoid ltd, Basingstoke, Hampshire, UK) agar to verify whether the bacterial population was *E. coli,* or not. Dyes Eosin and Methylene Blue react with products released by *E. coli* from lactose or sucrose as carbon and energy source, forming metallic green sheen regarded as positive isolate (Virpari et al., 2013).

3.5.3 Isolation of *Salmonella sp*

The samples were pre-enriched in BPA (Oxoid ltd, Basingstoke, Hampshire, UK), incubated at 37˚C for 16 hours. One ml of inoculums was transferred into Selenite-cystein broth (Oxoid ltd, Basingstoke, Hampshire, UK) after pre-enrichment (Carrique-Mas and Davies, 2008). A loopful of inoculums plated onto Xylose Lysine Deoxycholate (XLD) (Oxoid ltd, Basingstoke, Hampshire, UK) medium and incubated at 37˚C for 24 hrs. Black centered colony from XLD was inoculated in

Brilliant Green Agar (BGA) (Oxoid ltd, Basingstoke, Hampshire, UK) and incubated as well.

3.6 Techno-economical feasibility of malted milk hot drinks

Inventory Theory's model III is applied which states that economic lot size model with uniform rate of demand, finite rate of replenishment having no shortages (Including the basic theory of Inventory Theory). All the assumptions should be made for the production of malted milk hot drinks at minimum level. Set up cost was assumed on ground reality basis at minimum level (Kumar at al., 2013).

Chapter-4: Results

The prepared malted milk hot drink in the laboratory was designated as sample A and the collected samples also designated as sample B, sample C, sample D and sample E respectively.

4.1 Proximate composition of the malted milk hot drinks

4.1.1 Moisture

A one way analysis of variance (ANOVA) was carried out and the result revealed that there were significant variations ($p<0.05$) in moisture among the samples. Considering the data on moisture, the highest observed score was in case of sample A (9.18). The lowest preference in terms of moisture was in case of sample D and E (4.80).

Table 4.1: Chemical analysis of malted milk hot drinks

Quality parameters	Score (Mean)					SEM	Sign.
	A	B	C	D	E		
Moisture	9.18^{c}	8.35^{c}	5.73^{b}	4.80^{a}	4.80^{a}	0.62	***
Protein	11.23^{e}	5.48^{b}	4.58^{a}	8.67^{c}	9.22^{d}	0.83	***
Fat	4.90^{a}	4.94^{a}	4.53^{a}	8.46^{b}	4.34^{a}	0.52	***
Carbohydrate	71.57^{a}	78.19^{d}	82.06^{e}	75.61^{c}	73.91^{b}	1.21	***
Ash	3.10^{b}	3.09^{b}	3.11^{b}	2.46^{a}	7.74^{c}	0.65	***
Energy	385.14^{ab}	388.80^{b}	397.28^{c}	424.22^{d}	381.17^{a}	5.15	***

N.B: A= Sample A; B= Sample B; C= Sample C; D= Sample D; E= Sample E; SEM = Standard error of mean, ***= Significant at 0.1% level. Means with different superscripts in the same row differ significantly ($p<0.05$).

4.1.2 Protein

It is apparent from the result of ANOVA that there was highly significant difference ($p<0.05$) in terms of protein of the malted milk hot drinks. The result (Table- 4.1) indicates that the protein of the sample A was in highest position (11.27). The lowest preference in terms of protein was in case of sample C (4.58).Figure 4.1 showed the protein and carbohydrate content in simple bar diagram of the samples.

4.1.3 Fat

Highly significant fat differences ($p<0.05$) were revealed among the malted milk hot drinks samples (Table- 4.1). The DMRT test for fat preference was conducted and the finding suggested that the sample B, C and E were equally acceptable and significantly differs from others. The fat score of sample D (8.46) was the highest score among the samples of the malted milk hot drinks while sample E (4.34) obtained the lowest score among the samples.

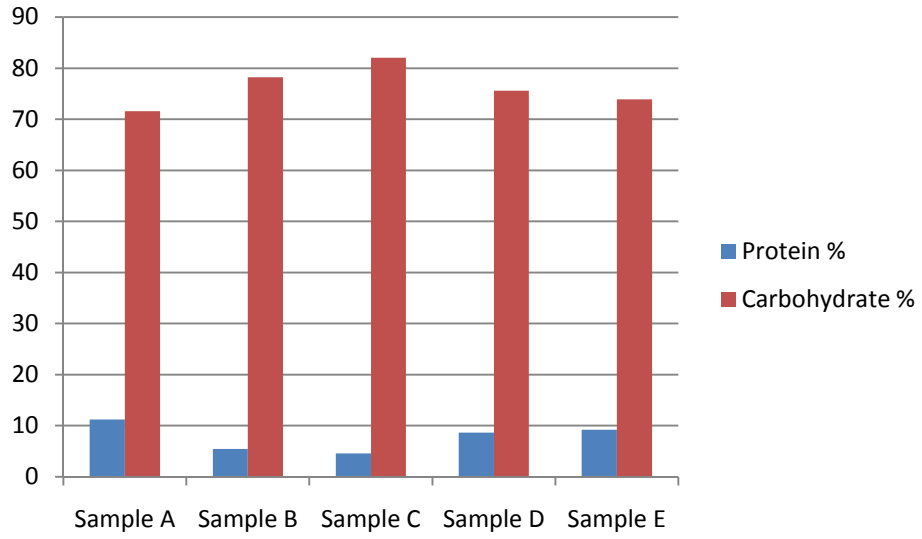

Figure 4.1: Protein and Carbohydrate content of the samples

4.1.4 Carbohydrate

In case of carbohydrate preference among the samples, a one way ANOVA showed that the samples were significantly different ($p< 0.05$). The data shows that, sample C (82.06) possesses highest score in case of carbohydrate and the lowest score was obtained the sample A (71.57).

4.1.5 Ash

From the result of ANOVA (Table- 4.1), it was apparent that there was highly significant difference ($p< 0.05$) in ash among the malted milk hot drinks. The result exhibits that the ash of the sample E (7.74) was in highest position. The lowest preference in terms of ash was in case of sample D (2.46).

4.1.6 Energy

Highly significant energy differences ($p<0.05$) were revealed among the malted milk hot drinks samples (Table- 4.1). The DMRT test for energy preference was conducted and the finding suggested that the sample A and E were equally acceptable and significantly differs from others. The energy score of sample D (424.22) was the highest score among the samples of the malted milk hot drinks while sample E (381.17) obtained the lowest score among the samples.

4.2 Sensory Evaluation

4.2.1 Sensory evaluation of malted milk hot drinks powder

The mean score for appearance, color, flavour, texture and overall acceptability of the powder samples were evaluated and the mean score of their responses are represented in Table- 4.2.

A one way analysis of variance (ANOVA) was carried out and the result revealed that there were highly significant variations ($p< 0.05$) in appearance, judged by panelist among the samples. Considering the data on appearance, the highest observed score was in case of sample C (8.0). The lowest preference in terms of appearance was in case of sample B (6.40).

It is apparent from the result of ANOVA that there was highly significant difference ($p<0.05$) in terms of color of the malted milk hot drinks. The result (Table- 4.2) indicates that the color of the sample D was in highest position (8.07) while the sample B (6.60) obtained lowest score among the samples.

Highly significant flavor differences ($p<0.05$) were revealed among the malted milk hot drinks samples (Table- 4.2). The flavor score of sample C (7.80) was the highest score among the samples of the malted milk hot drinks while sample A (6.20) obtained the lowest score among the samples.

Table 4.2: Analytical sensory evaluation of malted milk hot drinks powder

Quality parameters	Score (Mean)					SEM	Significance
	A	B	C	D	E		
Appearance	7.13[a]	6.40[a]	8.00[b]	7.13a[a]	7.00[a]	0.13	**
Colors	7.27[ab]	6.60[a]	8.07[b]	7.67[b]	6.80[a]	0.14	**
Flavours	6.20[a]	7.60[bc]	7.80[c]	7.53[b]	6.60[ab]	0.17	**
Texture	6.73	6.60	7.40	7.60	7.13	0.15	NS
Overall acceptability	6.93	7.20	7.87	7.60	7.27	0.13	NS

N.B: A= Sample A; B= Sample B; C= Sample C; D= Sample D; E= Sample E; SEM = Standard error of mean, NS = Non significant at 5% level, ** = Significant at 1% level.

Means with different superscripts in the same row differ significantly ($p<0.05$).

In case of texture preference among the samples, a one-way ANOVA showed that the samples were insignificantly different ($p>0.05$). The data shows that, sample D (7.60) possesses highest score in case of texture and the lowest score was obtained the sample B (6.60).

From the result of ANOVA (Table- 4.2), it was apparent that there were insignificant differences ($p> 0.05$) in overall acceptability among the malted milk hot drinks. The result exhibits that the overall acceptability of the sample C was (7.87) in highest position. The lowest preference in terms of overall acceptability was in case of sample A (6.93).

4.2.2 Sensory evaluation of malted milk hot drinks

The mean score for appearance, color, flavour, consistency and overall acceptability of the samples were evaluated and the mean score of their responses are represented in Table- 4.3.

A one-way analysis of variance (ANOVA) was carried out and the result revealed that there were insignificant variations ($p> 0.05$) in appearance, judged by panelist among

the samples. Considering the data on appearance, the highest observed score was in case of sample C (8.0). The lowest preference in terms of appearance was in case of sample E (6.60).

Table 4.3: Analytical sensory evaluation of malted milk hot drinks

Quality parameters	Score (Mean)					SEM	Significance
	A	B	C	D	E		
Appearance	7.07	7.20	8.00	7.47	6.60	0.16	NS
Colors	6.47^{a}	7.2^{ab}	7.73^{b}	7.4^{ab}	6.60^{a}	0.15	*
Flavours	6.47^{a}	7.53^{b}	7.80^{b}	7.73^{b}	6.93^{ab}	0.16	*
Consistency	7.00	7.73	7.60	7.80	6.93	0.15	NS
Overall acceptability	7.13^{a}	8.13^{b}	8.0^{b}	7.87^{b}	7.07^{a}	0.12	**

N.B: A= Sample A; B= Sample B; C= Sample C; D= Sample D; E= Sample E; SEM = Standard error of mean, NS = Non significant at 5% level, * = Significant at 5% level, ** = Significant at 1% level.

Means with different superscripts in the same row differ significantly ($p<0.05$).

It is apparent from the result of ANOVA that there was significant difference ($p<0.05$) in terms of color of the malted milk hot drinks. The result (Table- 4.3) indicates that the color of the sample D was in highest position (7.40).

Highly significant flavor differences ($p<0.05$) were revealed among the malted milk hot drinks samples (Table- 4.3). The DMRT test for flavor preference was conducted and the finding suggested that the sample A and E were equally acceptable and significantly differs from others. The flavor score of sample C (7.80) was the highest score among the samples of the malted milk hot drinks while sample A (6.47) obtained the lowest score among the samples.

In case of consistency preference among the samples, a one way ANOVA showed that the samples were insignificantly different ($p>0.05$). The data shows that, sample D (7.80) possesses highest score in case of consistency and the lowest score was obtained the sample E (6.93).

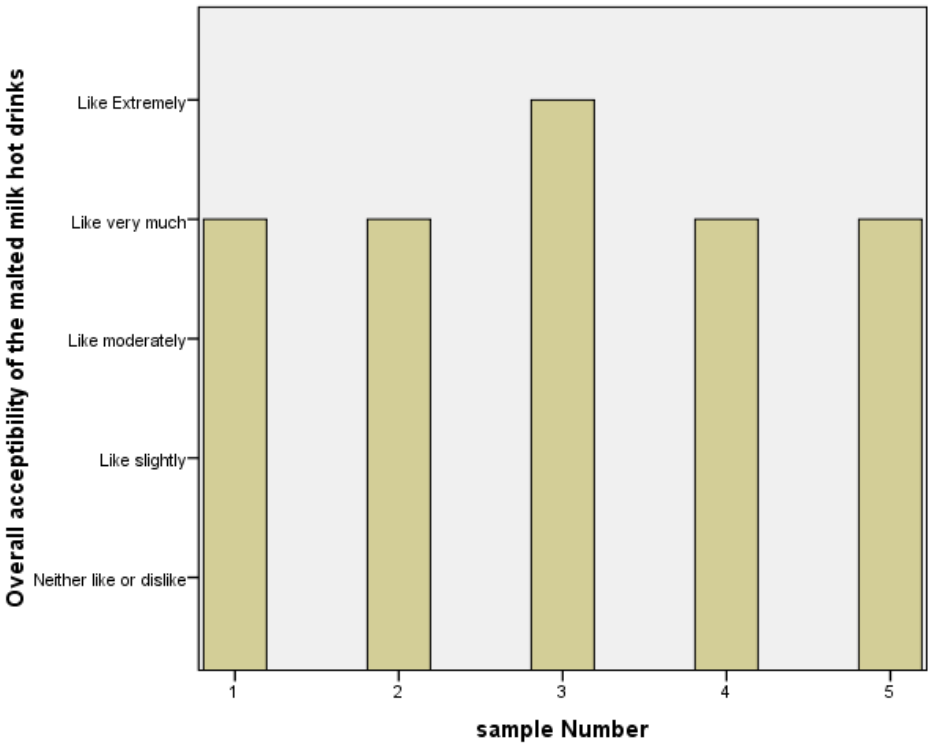

Figure 4.2: Overall acceptability of the malted milk hot drinks

N.B.: 1= sample A; 2= Sample B; 3= Sample C; 4= Sample D and 5= Sample E.

From the result of ANOVA (Table- 4.3), it was apparent that there was highly significant difference ($p< 0.05$) in overall acceptability among the malted milk hot drinks. The result exhibits that the overall acceptability of the sample B was (8.13) in highest position. The lowest preference in terms of overall acceptability was in case of sample E (7.07).

4.3 Bacteriological Investigation

There were no positive results of bacteriological investigation. There were no growth of S*almonella sp*, *Escherichia coli*, and *Staphylococcus sp* of any samples after six months.

Table 4.4: Production cost of malted milk hot drinks

Heads	Tk./Kg	Quantity used (kg/100kg)	Total Tk.
1. Expenditure			
Raw materials			
Barley	**40**	**38**	**1520**
Wheat Flour	**35**	**27**	**945**
Sugar	**65**	**13**	**845**
Skim milk powder	**400**	**14**	**5600**
Egg yolk powder	**300**	**0.5**	**150**
INS 500 (2)	**1000**	**0.5**	**500**
Cocoa powder	**900**	**6.5**	**5850**
Salt	**35**	**0.5**	**17.5**
Sub total			**15427.5**
b) Processing cost @ 15% of raw materials cost			**2314.125**
2) Handling cost excluding raw materials, packaging and processing			**2000**
Set up cost @ 7.0% (daily basis)			**310**
Total production cost of malted milk hot drinks/ 100 kg			**20051.625**

4.4 Techno-economic feasibility

The production cost of the developed malted milk hot drinks was calculated and Table 4.4 shows the cost per 100 Kg.

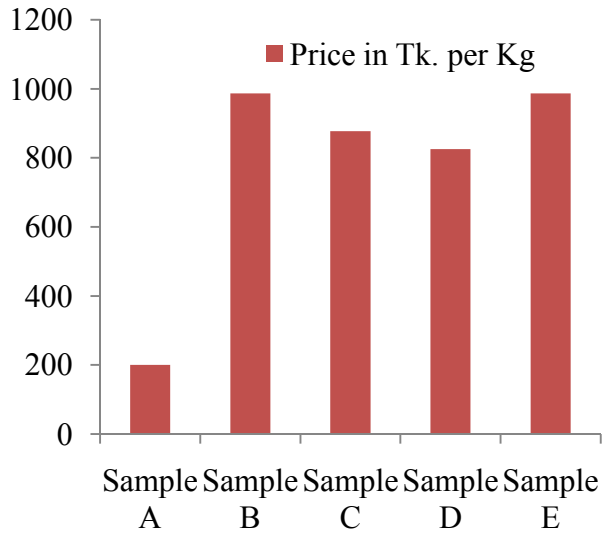

Figure 4.3: Commercial price of the malted milk hot drinks samples

As shown in Table 4.4, the production cost was approximately Tk. 200 per Kg. The commercial price of the sample B, C, D and E were 987, 877, 825 and 987 Tk. Per kg respectively. Figure 4.3 shows the price per Kg of the commercially available malted milk hot drinks which were selected for the comparison with the developed product.

Chapter-5: Discussions

The type of ingredients and their appropriate levels in the formulation are crucial to the development of an acceptable product (Singh et al., 2008).The proximate analysis of the developed drinks in this study showed that the drinks in this study contains high level of protein and are good source of energy which are expected due to starting raw materials. In the nutritional point of view supplementary malted milk hot drinks prepared in our laboratory was compared with the commercial malted milk hot drinks available in Bangladesh.

The protein content of the formulated milk hot drinks was 11.23g/100g where as sample B, C, D and E contained 5-48g/100g, 4.5g/100g, 8.67g/100g and 9.22g/100g respectively. The protein content of the formulated milk hot drinks was highest than the commercial malted milk hot drinks. This is because the high level of protein content of the raw material. The RDA of protein for children is 20.1g/day. According to the Indian council of Medical Research (1981) the recommended optimal protein caloric requirement for pre-scholars is 7.1% in total mixed diet. The formulated malted milk hot drinks contain 55.87% protein of the RDA requirements of protein for children. The protein rich diet is essential for the children in case of protein energy malnutrition. I think, the high level of protein of the developed malted milk hot drinks will play an important role to remove malnutrition in Bangladesh. The proximate result of the developed product was agreed with the reported by Kumar et al., (2013).

The carbohydrate content of the formulated malted milk hot drinks was 71.57g/100 whereas sample B, C, D and E contains 78.19g/100g, 82.06g/100g, 75.61g/100g and 73.91g/100g respectively. The formulated malted milk hot drinks contain the lowest carbohydrate content than the commercial malted milk hot drinks. This is because there is a highly significant negative correlation ($r = -0.963$) between the protein and carbohydrate content (Figure 4.1). Thus the increase in protein content reduces the carbohydrate content of the malted milk hot drinks (Parvin et al., 2014).

The fat content of the formulated malted milk hot drinks is 4.90g/100 g and the commercial malted milk hot drinks sample B, C, D and E contains 4.94g/100g, 4.53 g/100g, 4.53g/100g, 8.46g/100g and 4.34g/100g respectively. From the result, it was apparent that the fat content of the formulated malted milk hot drinks and the commercial brands was same except sample D. Food sample with high fat content is

more liable to spoilage than one with a lower fat content (Oduro et al., 2007).The ash content of the product gives an idea of the mineral content. The formulated malted milk hot drinks had appreciable level of ash contents (3.10g/100g) and sample B (3.09g/100g) and C (3.11g/100g) also had the same level of ash content.

The total energy content of the children's diet must be maintained with controlled limits. An insufficient energy intake could lead to failure to thrive, whereas an energy intake in excess of requirements may lead to obesity. The "energy density" (amount of energy in a given quantity of food) is, therefore important. The energy content of the formulated malted milk hot drinks was 385.14 Kcal/100g. For the commercial malted milk hot drinks such as sample (B, C, D and E) the energy densities were 388.80, 397.28, 424.22 and 381.17 Kcal /100g respectively. The RDA of energy for children is 1350 Kcal/day (ICMR, 2010). The formulated product and the sample B and E had same energy level and supply 221.63 Kcal per serving with added sugar and milk. Dietary Guidelines for Americans suggest 3 servings/d of fat-free or low-fat milk or equivalent milk for adults and children ages 9 to 18 y (Quann and Adams, 2013). Therefore, the product provide 49.25% calorie of RDA to meet the energy needs of the children.

Sensory characteristics of the developed products and the commercial malted milk hot drinks showed that the overall acceptability of the samples got the hedonic scale like very much, except sample C which got like extremely by the panelists (Figure 4.2). The results agreed with the report of Jacob et al., (2013). The results indicate that the formulated malted milk hot drinks are equally acceptable since it got the same hedonic scale of that commercial malted milk hot drinks sample B, D and E, although no artificial color and flavor were added to the formulated product which effects the score of the formulated product in terms of color and flavor (Table 4.2; 4.3). However, no significant difference in terms of appearance of the formulated products with the commercial products, which indicates positive sign for the developed product. The consistency of the developed product got the hedonic scale like moderately which prepared with lowest amount of products (80g/1L) than other commercial products and there were no significant differences in terms of consistency among the samples (Figure 3.1; Table 4.3). Thus, the developed product will give more serving from a fixed amount of product than the other commercial malted milk hot drinks. The bacteriological investigation was done after six months of the

preparation of the developed product. The formulated food sample and the commercial food samples were found to be totally absent from the *Salmonella Sp*, *Escherichia Coli* and *Staphylococcus Sp*. This indicates that the examined formulated malted milk hot drinks and the commercial samples were prepared from good quality raw materials, adequate thermal process and as a result of the good different processing conditions under which the production of formulates was carried out. The results agreed with the report of Parvin et al., (2014). Thus we can get an idea from these results about the shelf-life of the developed product which will be at least six months where the commercial product has a shelf-life of minimum one year. The shelf-life of the product can be increased by using the sophisticated equipments such as spray drier which will reduce the moisture content of the product below 5%.

As shown in table 4.4 the production cost of the developed malted milk drinks was approximately 200Tk. This price of the commercial malted milk hot drinks available in the market was around 4 times higher than the developed products (Figure 4.3). This is because, may be the commercial products are not manufactured in Bangladesh and may be they spent huge money in advertising the product and they imported the formulate product in Bangladesh and they just packaged and marketed it. The price of the developed product is very reasonable and low income people can also buy this product and fulfill their nutrients requirement. Yeasmin and Islam (2016) discussed that parent's socioeconomic condition directly affects the children's health outcomes. The poor family can give the drinks to their children for nourishment. There is a positive sign of this product that it will provide more servings than other commercial products which is helpful for the poor family.

Chapter-5: Conclusion

In Bangladesh, children malnutrition is an imperative health problem. To ensure growth and development of children proper nutrition is very important. Most of the malted milk hot drinks are imported in Bangladesh and these foods are usually beyond the affordable limit of people. Low cost local food ingredients were used to prepare a low cost food to meet the nutritional requirements of growing children. The formulated malted milk hot drink was found nutritionally rich and safe in bacteriological point of view comparable to commercial foods. The developed product was equally accepted by the test testing panel. This product has highly acceptable sensory values even without any addition of either of natural or artificial colour and flavour; whereas the commercial products use. This product could be an alternative of the imported commercial foods to meet the nutritional requirements of children.

Chapter-7: Recommendations and Future perspectives

The demand for easy to eat food has rapidly increased in recent year. The drinks can be easily made by adding hot water or milk with the addition of little sugar for taste. Alhamdulillah, the developed product had the nutrient content sufficient to meet the children's basic needs. The production cost of the developed product was very low. Now it is very important to spread the product with a low price in every family of Bangladesh. For this reason, local industry can pick up the product for large scale manufacturing and marketing throughout the country and could be benefited financially.

By adding flavor and color the quality of the product can be improved. Natural or food grade artificial colour and flavour can be used according to the children's choice. There are some minerals that play an important role in the child development such as Calcium, Zink, Iron and Magnesium etc. So, micro nutrients analysis is also important for exact nutritional value. Heavy metals content in food is increasing day by day. The analysis of heavy metal is also important. An appropriate packaging material for the product can also be selected which will protect the product from physical, chemical and microbial hazards with a cheap cost.

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Appendix A: Photo gallery

Barley

Grinding of the barley

Egg Yolk Powder

Barley Flour

Weighing of raw materials


Mixing of the developed product


Chemical analysis of the samples


Panel test for sensory evaluation

Microbial analysis of the samples

Appendix B: Rating score for different sensory attributes of malted milk hot drinks powder

Table 1: Rating Score for appearance of malted milk hot drinks powder

No. of taster	Sample -A	Sample -B	Sample -C	Sample -D	Sample -E
1	7.0	6.0	8.0	7.0	6.0
2	8.0	7.0	8.0	7.0	7.0
3	7.0	6.0	7.0	8.0	8.0
4	6.0	5.0	9.0	7.0	3.0
5	7.0	6.0	6.0	8.0	8.0
6	6.0	6.0	7.0	7.0	6.0
7	8.0	6.0	9.0	6.0	8.0
8	8.0	7.0	9.0	6.0	8.0
9	8.0	8.0	9.0	7.0	9.0
10	7.0	4.0	8.0	8.0	5.0
11	7.0	8.0	8.0	7.0	8.0
12	6.0	7.0	8.0	7.0	7.0
13	7.0	7.0	8.0	8.0	9.0
14	7.0	6.0	8.0	7.0	6.0
15	8.0	7.0	8.0	7.0	7.0
Mean score	7.13	6.40	8.00	7.13	7.00

Note:

- Sample A: Laboratory developed product
- Sample B, C, D and E: Commercial products available in local market

Hedonic Scale used: 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.

Table 2: Rating Score for colour of malted milk hot drinks powder

No. of taster	Sample -A	Sample -B	Sample -C	Sample -D	Sample -E
1	7.0	6.0	8.0	7.0	6.0
2	9.0	7.0	9.0	8.0	6.0
3	6.0	6.0	8.0	9.0	7.0
4	8.0	6.0	9.0	6.0	6.0
5	5.0	6.0	5.0	7.0	7.0
6	6.0	7.0	7.0	8.0	6.0
7	9.0	6.0	8.0	9.0	8.0
8	9.0	6.0	9.0	8.0	7.0
9	8.0	9.0	9.0	7.0	9.0
10	5.0	5.0	8.0	8.0	7.0
11	7.0	8.0	8.0	7.0	8.0
12	6.0	6.0	8.0	7.0	6.0
13	8.0	8.0	8.0	9.0	7.0
14	7.0	6.0	8.0	7.0	6.0
15	9.0	7.0	9.0	8.0	6.0
Mean score	7.27	6.60	8.07	7.67	6.80

Note:

* Sample A: Laboratory developed product
* Sample B, C, D and E: Commercial products available in local market

Hedonic Scale used: 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.

Table 3: Rating Score for flavor of malted milk hot drinks powder

No. of taster	Sample -A	Sample -B	Sample -C	Sample -D	Sample -E
1	8.0	8.0	7.0	7.0	7.0
2	4.0	9.0	9.0	8.0	4.0
3	6.0	9.0	8.0	8.0	7.0
4	8.0	8.0	8.0	8.0	6.0
5	5.0	5.0	6.0	7.0	6.0
6	4.0	6.0	5.0	8.0	8.0
7	8.0	9.0	8.0	8.0	9.0
8	8.0	9.0	8.0	6.0	6.0
9	8.0	8.0	9.0	8.0	8.0
10	5.0	4.0	7.0	8.0	5.0
11	6.0	7.0	9.0	7.0	8.0
12	6.0	7.0	8.0	7.0	6.0
13	5.0	8.0	9.0	8.0	8.0
14	8.0	8.0	7.0	7.0	7.0
15	4.0	9.0	9.0	8.0	4.0
Mean score	6.20	7.60	7.80	7.53	6.60

Note:

* Sample A: Laboratory developed product
* Sample B, C, D and E: Commercial products available in local market

Hedonic Scale used: 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.

Table 4: Rating Score for texture of malted milk hot drinks powder

No. of taster	Sample -A	Sample -B	Sample -C	Sample -D	Sample -E
1	6.0	7.0	7.0	8.0	8.0
2	7.0	8.0	8.0	7.0	6.0
3	9.0	7.0	7.0	8.0	7.0
4	1.0	8.0	8.0	7.0	7.0
5	6.0	5.0	6.0	9.0	8.0
6	5.0	5.0	6.0	6.0	6.0
7	9.0	6.0	7.0	7.0	7.0
8	9.0	6.0	8.0	8.0	8.0
9	8.0	7.0	8.0	8.0	8.0
10	6.0	4.0	7.0	8.0	6.0
11	7.0	8.0	8.0	8.0	8.0
12	6.0	6.0	7.0	7.0	6.0
13	9.0	7.0	9.0	8.0	8.0
14	6.0	7.0	7.0	8.0	8.0
15	7.0	8.0	8.0	7.0	6.0
Mean score	6.73	6.60	7.40	7.60	7.13

Note:

* Sample A: Laboratory developed product
* Sample B, C, D and E: Commercial products available in local market

Hedonic Scale used: 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.

Table 5: Rating Score for overall acceptability of malted milk hot drinks powder

No. of taster	Sample -A	Sample -B	Sample -C	Sample -D	Sample -E
1	7.0	7.0	8.0	7.0	7.0
2	7.0	8.0	9.0	7.0	6.0
3	7.0	9.0	8.0	8.0	8.0
4	6.0	7.0	8.0	7.0	6.0
5	6.0	7.0	6.0	8.0	9.0
6	5.0	6.0	5.0	8.0	8.0
7	8.0	7.0	7.0	9.0	8.0
8	8.0	8.0	9.0	7.0	8.0
9	9.0	7.0	9.0	8.0	9.0
10	6.0	4.0	7.0	8.0	4.0
11	7.0	8.0	8.0	8.0	8.0
12	6.0	7.0	8.0	7.0	7.0
13	8.0	8.0	9.0	8.0	8.0
14	7.0	7.0	8.0	7.0	7.0
15	7.0	8.0	9.0	7.0	6.0
Mean score	6.93	7.20	7.87	7.60	7.27

Note:

* Sample A: Laboratory developed product
* Sample B, C, D and E: Commercial products available in local market

Hedonic Scale used: 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.

Appendix C: Rating score for different sensory attributes of malted milk hot drinks

Table 1: Rating Score for appearance of malted milk hot drinks

No. of taster	Sample -A	Sample -B	Sample -C	Sample -D	Sample -E
1	9.0	8.0	9.0	9.0	7.0
2	9.0	8.0	9.0	9.0	7.0
3	7.0	6.0	5.0	6.0	7.0
4	4.0	7.0	7.0	7.0	6.0
5	8.0	8.0	9.0	7.0	8.0
6	8.0	7.0	8.0	7.0	8.0
7	3.0	5.0	8.0	8.0	4.0
8	5.0	6.0	6.0	5.0	6.0
9	7.0	8.0	9.0	7.0	8.0
10	7.0	7.0	8.0	7.0	5.0
11	5.0	7.0	8.0	6.0	6.0
12	7.0	8.0	7.0	8.0	5.0
13	9.0	7.0	9.0	8.0	8.0
14	9.0	8.0	9.0	9.0	7.0
15	9.0	8.0	9.0	9.0	7.0
Mean score	7.07	7.2	8.0	7.47	6.6

Note:

- Sample A: Laboratory developed product
- Sample B, C, D and E: Commercial products available in local market

Hedonic Scale used: 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.

Table 2 Rating Score for colour of malted milk hot drinks

No. of score	Sample -A	Sample -B	Sample -C	Sample -D	Sample -E
1	8.0	6.0	9.0	7.0	7.0
2	8.0	7.0	9.0	8.0	7.0
3	7.0	8.0	4.0	6.0	7.0
4	2.0	6.0	7.0	7.0	6.0
5	7.0	8.0	9.0	8.0	7.0
6	6.0	7.0	7.0	7.0	6.0
7	5.0	6.0	8.0	8.0	6.0
8	5.0	6.0	5.0	5.0	6.0
9	7.0	8.0	8.0	8.0	8.0
10	7.0	8.0	8.0	7.0	7.0
11	5.0	8.0	9.0	8.0	7.0
12	5.0	8.0	7.0	8.0	5.0
13	9.0	9.0	8.0	9.0	6.0
14	8.0	6.0	9.0	7.0	7.0
15	8.0	7.0	9.0	8.0	7.0
Mean score	6.47	7.2	7.73	7.4	6.6

Note:

* Sample A: Laboratory developed product
* Sample B, C, D and E: Commercial products available in local market

Hedonic Scale used: 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.

Table 3: Rating Score for flavor of malted milk hot drinks

No. of taster	Sample -A	Sample -B	Sample -C	Sample -D	Sample -E
1	8.0	8.0	9.0	9.0	7.0
2	8.0	8.0	9.0	9.0	7.0
3	6.0	6.0	5.0	5.0	7.0
4	4.0	8.0	7.0	8.0	7.0
5	6.0	8.0	9.0	7.0	7.0
6	7.0	8.0	8.0	7.0	8.0
7	6.0	7.0	7.0	7.0	5.0
8	4.0	6.0	5.0	6.0	5.0
9	7.0	7.0	8.0	8.0	9.0
10	6.0	7.0	8.0	7.0	9.0
11	5.0	8.0	9.0	8.0	7.0
12	5.0	8.0	6.0	8.0	5.0
13	9.0	8.0	9.0	9.0	7.0
14	8.0	8.0	9.0	9.0	7.0
15	8.0	8.0	9.0	9.0	7.0
Mean score	6.47	7.53	7.8	7.73	6.93

Note:

* Sample A: Laboratory developed product
* Sample B, C, D and E: Commercial products available in local market

Hedonic Scale used: 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.

Table 4; Rating Score for consistency of malted milk hot drinks

No. of taster	Sample -A	Sample -B	Sample -C	Sample -D	Sample -E
1	9.0	8.0	9.0	9.0	7.0
2	9.0	8.0	9.0	9.0	7.0
3	7.0	8.0	6.0	7.0	7.0
4	6.0	7.0	5.0	8.0	8.0
5	8.0	8.0	9.0	7.0	7.0
6	7.0	6.0	7.0	7.0	6.0
7	6.0	7.0	7.0	7.0	6.0
8	6.0	7.0	6.0	6.0	6.0
9	6.0	7.0	7.0	7.0	8.0
10	7.0	8.0	8.0	8.0	7.0
11	6.0	9.0	9.0	9.0	7.0
12	2.0	8.0	6.0	6.0	5.0
13	8.0	9.0	8.0	9.0	9.0
14	9.0	8.0	9.0	9.0	7.0
15	9.0	8.0	9.0	9.0	7.0
Mean score	7.0	7.73	7.6	7.8	6.93

Note:

* Sample A: Laboratory developed product
* Sample B, C, D and E: Commercial products available in local market

Hedonic Scale used: 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.

Table 5: Rating Score for overall acceptability of malted milk hot drinks

No. of taster	Sample -A	Sample -B	Sample -C	Sample -D	Sample -E
1	8.0	9.0	9.0	9.0	8.0
2	8.0	9.0	9.0	9.0	8.0
3	7.0	6.0	5.0	6.0	6.0
4	6.0	8.0	7.0	7.0	5.0
5	8.0	8.0	9.0	7.0	8.0
6	7.0	8.0	8.0	7.0	8.0
7	6.0	8.0	8.0	8.0	7.0
8	7.0	7.0	6.0	7.0	7.0
9	7.0	8.0	8.0	8.0	8.0
10	7.0	8.0	9.0	8.0	7.0
11	6.0	8.0	8.0	8.0	7.0
12	6.0	8.0	7.0	8.0	5.0
13	8.0	9.0	9.0	8.0	6.0
14	8.0	9.0	9.0	9.0	8.0
15	8.0	9.0	9.0	9.0	8.0
Mean score	7.13	8.13	8.0	7.87	7.07

Note:

* Sample A: Laboratory developed product
* Sample B, C, D and E: Commercial products available in local market

Hedonic Scale used: 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.

TASTE TESTING FOR MALTED MILK HOT DRINKS
(Hedonic Rating Test)

Name of the Tester ---------- Date : ----------

Please taste these Samples and check how much you like or dislike each one on five Sensory attributes such as Appearance, Colour, Flavour, Consistency and Overall Acceptability. Use the appropriate scale to show your attitude by checking at the point that best describes your feeling about the Sample. Please give a reason for this attitude. Remember you are the only one who can tell what you like. An honest expression of your personal feeling will help us.

Hedonic	Appearance					Colour					Flavour					Consistency					Overall Acceptability				
	Sample					Sample					Sample					Sample					Sample				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Like extremely																									
Like very much																									
Like moderately																									
Like slightly																									
Neither like nor dislike																									
Dislike slightly																									
Dislike moderately																									
Dislike very much																									
Dislike extremely																									

Extra comments on each sample, if any
N.B: Overall Evaluation:

Hedonic Scale used : 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 .

TASTE TESTING FOR MALTED MILK POWDER MIXER

(Hedonic Rating Test)

Name of the Tester ---------- Date: ----------

Please taste these Samples and check how much you like or dislike each one on five Sensory attributes such as Appearance, Colour, Flavour, Texture and Overall Acceptability. Use the appropriate scale to show your attitude by checking at the point that best describes your feeling about the Sample. Please give a reason for this attitude. Remember you are the only one who can tell what you like. An honest expression of your personal feeling will help us.

Hedonic	Appearance					Colour					Flavour					Texture					Overall Acceptability				
	Sample					Sample					Sample					Sample					Sample				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Like extremely																									
Like very much																									
Like moderately																									
Like slightly																									
Neither like nor dislike																									
Dislike slightly																									
Dislike moderately																									
Dislike very much																									
Dislike extremely																									

Extra comments on each sample, if any

N.B: Overall Evaluation:

Hedonic Scale used : 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 .

Brief Biography

Abdul Matin passed the Secondary School Certificate Examination in 2006 and then Higher Secondary Certificate Examination in 2008. He also received Bachelor of Food Science and Technology (BFST) degree from Faculty of Food Science and Technology, Chittagong Veterinary and Animal Sciences University, Khulshi, Chittagong. Now, he is a candidate for the MS degree in Food Processing and Engineering under the Department of Food Processing and Engineering of same faculty.

He joined as a Lecturer in the Department of Food Processing and Engineering, Faculty of Food Science and Technology, Chittagong Veterinary and Animal Sciences University (CVASU) in 2015. His research interests are in the areas of Product development, Natural preservatives, Bio preservation of food.