DEVELOPMENT AND QUALITY EVALUATION OF MIXED FRUITS DRINKS POWDER

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Roll No.: 0119/22

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The thesis submitted in the partial fulfillment of the requirements for the degree of Masters of Science in Applied Human Nutrition & Dietetics

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DEDICATED TO MY RESPECTED AND BELOVED PARENTS AND TEACHERS

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List of Abbreviations

AOAC	Association of Official Analytical Chemists
APM	Aspartame
BCSIR	Bangladesh Council of Scientific and Industrial Research
Ca	Calcium
CAD	Coronary Artery Disease
CHO	Carbohydrate
CMC	Carboxymethyl cellulose
DPPH	2,2 – diphenyl – 1 –picrylhydrazyl
DV	Daily Value
FAO	Food and Agriculture Organization
FAOSTAT	Food and Agriculture Organization Corporate Statistical Database
Fe	Iron
GABA	Gamma aminobutyric acid
GAE	Gallic Acid Equivalent
HFCS	High Fructose Corn Syrup
K	Potassium
Mg	Magnesium
Mn	Manganese
MPN	Most probable number
Na	Sodium
ND	Not Detected
P	Phosphorus
PDPC	Papaya, Dates, Pineapple and carrots
PMS	Premenstrual Syndrome
QE	Quercetin
SDA	Sabouraud dextrose agar

TAC	Total Anthocyanin Content
TCC	Total Coliform Count
TE	Trolox Equivalent
TFC	Total Flavonoid Content
TPC	Total phenolic content
TVC	Total viable count
USDA	United States Department of Agriculture
VAT	Value added tax
Zn	Zinc
&	And

Abstract

The purpose of the study was to develop powdered drinks made from mixed fruits (dried dates, ripe papaya, pineapple and carrots) with good nutritional facts. In this study, Crude fiber was found in all formulated mixed fruits drinks powder and protein, fat, moisture, fiber, ash, carbohydrate, and energy content were ranged from 2.6% to 1.2%, 1.4% to 1.0%, 4.9%, 1.1% to 0.5%, 3.6% to 3.5%, 88.0% to 87.3% and 377.0 to 367.5 kcal/100 g, respectively. Highest content of sodium, potassium, chloride, calcium (were ranged from 397.8 to 365.4 mg/dl, 9.4 to 5.4 mg/dl, 23.4 to 16.7 mg/dl, and 3.4 to 2.1 mg/dl respectively) and lowest content of phosphorus, magnesium, iron (were range from 2.8 - 1.4 mg/dl, 0.7 - 0.3 mg/dl and 0.1 - 0.0 mg/dl) were found in the presently formulated mixed fruits drinks powder. Largest content of vitamin A (ranged from 462.1 to 434.2 µg/100g) and lowest content of vitamin C (ranged from 16.7 to 11.7 mg/dl) were found in developed mixed beverage/fruits drinks powder. Highest content of total flavonoid content, total anthocyanin content (were ranged from 35.4 to 11.6 mg/100g and 153.3 to 149.4 mg/100g) and lowest content of antioxidant capacity, total phenolic content (were ranged from 2.7 to 2.1 mg/100g and 4.6 to 4.3 mg/100g) were found in the presently formulated all mixed fruits drinks powder. From a sensory and microbiological perspective, the currently developed mixed fruit drinks powder was deemed to be extremely acceptable for up to six months. The prepared mixed fruits drinks powder is therefore nutritionally acceptable when compared to commercially available fruits drinks powders and is suitable to meet daily nutritional needs.

Keywords: Fat, minerals, vitamin, powders, mixed fruits, proximate, drinks, sensory, supplement

Chapter I: Introduction

Fresh fruit is perishable and has a limited shelf life. Raising shelf life, a variety of processing and preservation techniques are used, including as dehydration, chemical methods, and different packaging techniques. The most common food processing technique for extending shelf life is drying. The goal of drying mixed fruits and vegetable juice/pulp is to create a stable and easy-to-handle version of the juice that can be quickly reconstituted into a high-quality product that closely resembles the original juice. Fruits can be significantly reduced in volume by being dehydrated into powdered form, which is a great technique to increase span of time (Mahendran, 2011). Moving goods to far-off markets may result in much lower storage and transportation expenses. Because dries juice products have a long shelf life at room temperature, they are mostly employed as convenience goods nowadays (Pap, 1995). Fruits powders that have been completely dried are frequently utilized in food preparations. Hard candy, toffee, and candy can be made with fruit powders with a moisture percentage of less than 4% (wb). The most effective methods for creating fruit juice/drinks powder include foam mat and spray drying, vacuum drying and freeze drying. These drying processes are employed in cabinets. Consuming fruits and vegetables or its juice can reduce mortality, improve mental and cardiovascular health, lower the risk of various diseases, and help us control our weight, among other things. An American study found that healthy middle-aged women who eat fruits have a lower chance of becoming obese (He, et al., 2004). Fruits in particularly include enough potassium, which is necessary to lessen the impact of bone loss and the formation of kidney stones. Fruits help the brain operate properly because they promote memory recall and give the body the fiber it needs for a healthy diet and lifestyle (Ridgewell, 1998). Fruits are also a great source of nutritional elements like folic acid and antioxidants (Ness and Powles, 1997; Tribble, 1999). Consuming fruits ensures maximum health, provides the body with instant energy, and delivers vitamins and minerals that are good for body functioning. Fruits also help with weight control, promote healthy skin and hair, and avoid constipation, hemorrhoids, and diarrhea.

Tropical fruit known as **papayas** (*Carica papaya L.)* are found in the Philippines, Hawaii, Australia, Sri Lanka, Malaysia, South Africa, India, Bangladesh and other tropical nations (Anuara, 2008). When the trees are too tall to harvest after one to two years, harvesting begins (Gonsalves, 1998). The leading papaya growers are Mexico, Brazil, and India. The biggest papaya grower in the US is Hawaii; approximately sixty six percent of maximum fresh output is exported, primarily to Japan and the United States mainland (Gonsalves et al., 2006). CHO, vitamin C, vitamin A and minerals (magnesium and copper) are all rich in papaya fruit (wall, 2006; Souza et al., 2008; kalou et al., 2011). Fresh papaya fruits are perishable, making their exportation difficult. Due to a lack of or poor storage facility, large amounts of papaya are discarded each year. As a result, the critical elements (vitamins) contained in papaya fruits are lost, as well as the cash generated from their sale (Awe, 2011). **Dates** (*Phoenix dactylifera L.)* are a valuable plant in the sweltering regions of North Africa and Southwest Asia (Dowson, 1982; Zaid, 1999; Al Farsi and Lee, 2008). Fruits, which are the most widely used component, are a vital source of nutrients, particularly in desert locations where few plants can thrive due to the harsh environment. Dates are referred to as Sugar Palm- English, Karjura- Kannada, Karchuram- Malayalam, Tamil, Khajur-Urdu, Hindi and Nakhal- Arabic in conversational languages (Zaid, 1999; Al-Shahib and Marshall, 2003). Dates are precious to Muslims all over the world, and they are mentioned lots of times in the Holy Quran. To relieve the 24-hour fasting during the religious month of Ramadan, they are typically employed (Dowson, 1982; Al-Shahib and Marshall, 2003; Al Farsi and Lee, 2008). Dates are 70 percent carbohydrate, with sugars making up the majority of that content. When dates are dried, the water activity reduces, resulting in an increase in sugar concentration. Dry dates may therefore be kept for a very long time and have a longer life (Al-Shahib and Marshall, 2003). A warm environment and plentiful rainfall are required for the production of **pineapples** (Ananas Comosus) in tropical and subtropical locations**.** Fruits can be classed as climacteric or non-climacteric based on their respiration rate. Non-climacteric fruits emit less ethylene than climacteric fruits do (Paul et al., 2012). Millions of tons of pineapples are grown each year as a non-climacteric fruit. Although pineapples are categorized as non-climacteric fruits, their peel color develops in the same way that climacteric fruits do, and the 20 percent yellow color stage is ideal for harvesting. Pineapples are ripened using both natural and artificial methods. Various ripening techniques, on the other hand, may provide different nutrient levels and taste profiles, altering customer preferences (Ikram et al., 2021). Pineapples are high in calcium-binding vitamins, antioxidants, and enzymes, as well as generally pro compounds. Fruits change in texture, color, aroma, and flavor at the last stage of maturing as a result of a sequence of biochemical and physiological processes, making them more enticing, delicious, and appealing (Steingass et al., 2015). **Carrot** (Daucus carota) is a colorful annual crop belonging to the Apiaceae (formerly Umbelliferae) family that is planted around the globe for edible purposes. Crop cultivation is preferred in tropical and subtropical regions from September to November, although temperate regions offer a wide range of alternatives for crop cultivation all year round. The crop requires a chilly temperature to produce seeds. The root crop known as the carrot has a single color and is rich in flavonoids and carotenoids, which have protective properties in addition to their color (Rodriguez-Amaya, 2001). The surface of the root is where the bioactive elements are primarily concentrated (cortex), and It has been included in the top ten fruits and vegetables in terms of nutritional content by (Alasalvar et al., 2001) due to the presence of a substantial amount of minerals, vitamins, and bioactive components. The variations in pigments are what give red, orange, yellow, violet, black, or white stems their color (Haq and Prasad, 2014). It’s processing and marketing into a variety of goods, particularly as a cheap source of vitamin A, is essential for supplying people's nutritional needs. When compared to other carotenoids, the conversion of vitamin A from - carotene is very fast (Van Vliet et al., 1996), and Carrots have considered to provide 14–17% of the recommended daily intake of vitamin A (Heinonen et al., 1990; Block, 1994).

Drinking a mixed fruit drinks instantly rehydrates and refreshes us. It is mainly effective during the summer months. A delightful fruit-flavored drink with minerals and vitamins is made using mixed fruits drinks powder. It makes a delicious drink that gives us an extra boost of energy and revitalizes us. When blended with water, a high-energy mixed fruits drinks powder provides an immediate breakfast drink with good nutrients source such as vitamin, minerals, protein, fat, CHO, fiber, bioactive compound and other various beneficial nutrients and will get different taste of several fruits together that has high nutritional, therapeutic, functional and industrial properties. Consumers may be drawn to mixed fruits drinks powder because of its good nutrient source, health beneficial, palatability, beautiful color, and varied flavor and taste. As a result, it has a good chance of gaining customer acceptability. The developed natural mixed fruits drinks powder will facilitate the people to meet their nutritional demand. This can also be used as a better alternative of the artificial powder drinks available in market. This better drinks powder will also help to increase the immunity among the people.

Aims & Objectives

- To formulate mixed fruits drinks powder.
- To evaluate the Proximate and bioactive components of powdered mixed fruit drinks.
- To assess the microbiological quality and its consumer's acceptance.

Chapter II: Literature review

Processing and preservation of various fruits and vegetables is crucial on a global scale. Fruits are perishable foods, and postharvest deterioration is responsible for the majority of losses, which are estimated to be between 40 and 50 percent in the tropics and subtropics. This research was part of a larger effort to reduce post-harvest losses and create a healthful drinks powder made from mixed fruits.

2.1 Papaya (*Carica papaya)*

A papaya tree is a little plant with few branches that only has spiral-shaped leaves at the top of the stem and can reach heights of 5 to 10 meters (16 - 33 ft). The bottom stem is clearly damaged where leaf and fruit were produced. The enormous leaves are between 50 and 70 centimeters long (20–28 inches) in diameter and have seven lobes. The plant's entire body contains latex in flexible laticifers (Heywood et al., 2007). The characteristics of dame bloom include an upper ovaries and five curled petals that are loosely connected at the base (De Craene, 2022). The fruit is a big berry that measures between 15 and 45 cm in length and 10 and 30 cm in diameter. When fruit feels soft (at least as soft as ripe avocados) and the skin has gone from amber to orange, it is ripe and numerous black seeds are adhered to the walls of the huge central chamber (Heywood et al., 2007).

2.1.1 Scientific classification of papaya:

Table 2.1.1.1 Papaya classification

Classification of papaya	
Kingdom	plantae
Order	Brassicales
Family	*Caricaceae*
Genus	*Carica*
Species	*C. papaya*
Source: National Plant Germplasm System of the U.S., 2011	

2.1.2 Papaya production and Nutritional value

Papayas often come in two varieties. The sweet, red or orange flesh of one is termed "red papaya," while the yellow flesh of the other is called "yellow papaw" in Australia. A "green papaya" is any type of papaya that is picked green. The popular papaya varieties "Sunrise," "Maradol," and "Caribbean Red" with their large, red fruits and flesh are grown in Belize and Mexico (Morton, 1987). Global papaya production reached 13.9 million tons in 2020, with India accounting for 43% of the total (table 2.1.2.1). In the early twenty-first century, global papaya output surged dramatically, owing primarily to rising demand from the United States and output in India. The world's largest papaya consumer is the United States (Umamagheswari et al., 2014)

Table 2.1.2.1 Papaya production

Production of Papaya -2020	
Country	Millions of tons
Bangladesh	0.8
Brazil	1.2
Dominican Republic	1.3
India	6.0
Indonesia	1.0
Mexico	1.1
World	13.9
Source: United Nations FAOSTAT, 2020	

Papaya pulp has a water content of 88%, a carbohydrate content of 11%, and very little protein and fat. While papaya fruit has a low nutritional content overall, in a 100-gram serving, it provides a fair amount of folate (10 percent DV) and a large quantity of vitamin- C (75 percent of the DV) (table 2.1.2.2).

Table 2.1.2.2 Nutritional value of papaya per 100 gram

Nutrients	Nutrient value	Nutrients	Nutrient value
Energy	179 kj (43 kcal)	Minerals	
Protein	0.47 g	Zn	0.08 mg
Fat	0.26 g	Na	8 mg
Sugar	7.82 g	P	10 mg
Carbohydrates	10.82 g	Mg	21 mg
Dietary fiber	1.7 g	K	182 mg
Vitamins		Ca	20 mg
Vitamin E	0.3 mg	Fe	0.25 mg
Vitamin k	2.6 µg	Water	88 g
Thiamine (B_1)	0.023 mg	Lycopene	1828 µg
Riboflavin (B_2)	0.027 mg		
Niacin (B_3)	0.357 mg		
Folate (B_9)	38 µg		
Vitamin C	62 mg		
Beta carotene	274 µg		
Vitamin A	47 µg		
Source: USDA Food Data base, 2018			

2.1.3 Bioactive compounds of Papaya

Carotenoids and polyphenols are among the phytochemicals found in papaya skin, pulp, and seeds (Rivera Pastrana et al., 2010). During maturation, levels of pulp and skin increase, along with benzyl isothiocyanates and benzyl glucosinates (Rossetto et al., 2008). The yellow skin is rich in the carotenoids beta-carotene and lutein, but in the crimson flesh, carotene predominates. The cyanogenic compound prunasin is also present in papaya seeds (Shen et al., 2019).

2.2 Dates (*Phoenix dactylifera)*

Date palm is a species of Phoenix dactylifera. In the palm group Arecaceae, dates are a kind of plant called that are grown primarily their delicious, fruitiness. Numerous tropical and subtropical regions around the world have naturalized the specie, which is widely planted in the South Asia, Middle East and northern Africa. The typical member of the group Phoenix, which includes 12 to 19 varieties of wild date palms, is *P. dactylifera* (Krueger, 2018). The fruit is a good strength source with hundred gram of flesh giving about 314 kcal (Al Farsi and Lee, 2008).

2.2.1 Scientific Classification of Dates

Table 2.2.1.1 classification of dates

Dates Classification	
Kingdom	Plantae
Order	Arecales
Family	*Arecaceae*
Genus	*phoenix*
Species	*P. dactylifera*
Source: U.S. National plant Germplasm System, 2011	

2.2.2 Production and Nutritional value of Dates

Egypt, Saudi Arabia, Iran, and Algeria produced 9 million tons of dates in 2020, accounting for 60% of the global total.

Table 2.2.2.1 Production of dates

Dates production -2020	
Country	Tons
Algeria	1,151,909
Egypt	1,690,959
Iran	1,283,499
Iraq	735,353
Pakistan	543,269

Saudi Arabia	15,41,769
Sudan	465,323
World	9,454,213
Source: FAOSTAT of United Nations, 2020	

75% of dates' calories come from carbs (63 percent sugars and 8 percent dietary fiber), less than 1 percent fat, 2% protein and 21 % water on average (table 2.2.2.2). As a reference, one date provides 1,180 kJ (280 kcal) of dietary energy and are a fair sources of pantothenic acid (10–19% of the Daily Value), vitamins, and the dietary minerals potassium and magnesium, as well as other trace levels of micronutrients. Dates contain roughly 55 percent glucose, 45 percent fructose, and very little sucrose in terms of sugar concentration (Yasawy, 2016). Five different types of dates' glycemic index (GI) ranged from 46 to 55, according to a 2011 study (Salehpour et al., 2012). Dates are a food source with a relatively low GI, according to research from 2002, which showed GI values of 31–50 (Miller et al., 2002).

Table 2.2.2.2 Nutritional value of dates per 100 gram

Nutrients	Nutrient value	Nutrients	Nutrient value
Energy	1,180 kJ (280 kcal)	Minerals	
Fat	0.4 g	P	62 mg
Dietary fiber	8 g	Mg	43 mg
Sugar	63 g	Na	2 mg
Carbohydrates	75.0 g	K	656 mg
Protein	2.4 g	Ca	39 mg
Vitamins		Fe	1.02 mg
Vitamin E	0.05 mg	Zn	0.29 mg
Vitamin k	2.7 µg	Water	20.5 g
Thiamine (B_1)	0.052 mg		
Riboflavin (B_2)	0.066 mg		
Niacin (B_3)	1.274 mg		
Folate (B_9)	19 µg		
Vitamin C	0.4 mg		
Vitamin A	6 µg		
Beta carotene	75 µg		
Source: USDA Food Data base, 2018			

2.2.3 Bioactive compounds of dates

Phytochemicals such carotenoids, flavonoids, sterols, phenolics, anthocyanins, and procyanidins are plentiful in the pulp of dates. Fruit type, picking stage, location, and soil characteristics all affect the ratio and concentrations of these components. These phytochemicals also help the fruits' nutritive and organoleptic qualities. (Hulme, 1970; Ahmed et al., 1995; Abdelhak et al., 2005).

2.3. Pineapple (*Ananas comosus*)

The pineapple is the Bromeliaceae family's most important commercial plant, a fruit-bearing tropical plant. The pineapple is a South American native that has long been farmed there. After being brought to Europe in the 17th century, the pineapple quickly gained fame as a cultural representation of wealth. Pineapples have been produced for commercial purposes on numerous tropical plantations and in greenhouses since the 1820s. The unpollinated plant's individual blossoms unite to produce a lot of fruits and a little bush is formed when pineapples develop. Usually, this margin made at the apex of the fruits serves to multiply plants (Leal et al., 2003). Furthermore, during pineapple maturation, citric acid, reducing sugars, sucrose, pH, alcoholinsoluble particles, and titrable acids in the core revealed consistent trends of improvement (Ong et al., 2006). Because naturally ripened fruits are perishable, chemicals that are harmful to human health, such as ethephon, ethylene, and calcium carbide, is employed to mature & extend the span of time of the fruits. Simulated maturing has potential to taint the fruit as well as induce toxicity (De et al., 2021).

2.3.1 Scientific Classification of Pineapple

Table 2.3.1.1 Pineapple classification

Classification	
Kingdom	Plantae
Order	Poales
Family	*Bromeliaceae*
Genus	*Ananas*
Species	*A.comosus*
Source: U.S. National plant Germplasm System, 2014	

2.3.2 Production and Nutritional value of Pineapple

The Brazil, Indonesia, Costa Rica, Philippines, and China were the leading pineapple growers in 2020, with 28 million tons produced globally. (Table 2.3.2.1)

Table 2.3.2.1 Production of pineapple

Production of pineapple -2020	
Country	Millions of tons
Brazil	2.5
China	2.2
Costa Rica	2.6
Indonesia	2.4
Philippines	2.7
Thailan	1.7
World	27.8
Source: United Nations FAOSTAT, 2020	

86 % of pineapple pulp is water, 0.5 % protein, 13 % carbs & very little fat. In a 100 g standard quantity, *Ananas* contains few or no micronutrients in meaningful amounts; it provides 209 kilojoules (50 kcal) of dietary energy and is a great vitamin C source (58% DV) and manganese (44 %, DV) (Table 2.3.2.2).

Table 2.3.2.2 Nutritional value of Pineapple per 100 gram

Nutrients	Nutrient value	Nutrients	Nutrient value
Energy	209 kJ (50 kcal)	Minerals	
Fat	0.12 g	P	8 mg
Protein	0.54 g	Na	1 mg
Dietary fiber	1.4 g	K	109 mg
Carbohydrates	13.12 g	Mg	12 mg
Sugar	9.85g	Ca	13 mg
Vitamins		Fe	0.29 mg
Thiamine (B_1)	0.079 mg	Zn	0.12 mg
Riboflavin (B_2)	0.032 mg	Mn	0.927 mg
Niacin (B_3)	0.5 mg	water	86 g
Folate (B_9)	18 µg		
Vitamin C	47.8 mg		
Source: USDA Food Data base 2018			

2.3.3 Bioactive compounds of Pineapple

Polyphenols such as arbutin, gallic acid, ferulic acid, coumaric acid, syringic acid, vanillin, sinapic acid, chlorogenic acid, and epicatechin, are among the phytochemicals present in pineapple fruits & peels (Li et al., 2014; Ogawa et al., 2018)

2.4 Carrots (*Daucus carota*)

The root vegetable known as the carrot is typically orange in color. However, the endemic to European and southwest Asia wild carrot, *Daucus carota*, also comes in farmed variants. The plant was initially grown for its leaves and seeds, and it possibly came from Persia. The taproot of the plant is the component that is most frequently consumed; however the leaves and stems are also consumed. Cultivated carrots have undergone selective breeding to produce a taproot that is larger, more appetizing, and less woody in texture. The Apiaceae family of umbellifers, which includes the carrot, is a flowering plant. It initially develops a crown of leaves while spreading the taproot. Fast-growing cultivars reach maturity 90 days after the seed is planted, whereas slower-growing cultivars require an additional month (one hundred twenty days). The stems are a strong source of vitamins A, K, and B6 and contain significant amounts of alpha- and beta-carotene (Iorizzo et al., 2013; Sifferlin, 2018; Iorizzo et al., 2020).

2.4.1 Scientific Classification of Carrots

Table 2.4.1.1 classification of carrots

Classification of carrots	
Kingdom	Plantae
Order	Apiales
Family	*Apiaceae*
Genus	*Daucus*
Species	*D. Carota*
Sub species	*D.c.Subsp. Sativus*

Source: U.S. National plant Germplasm System, 2020

2.4.2 Production and Nutritional value of Carrots

In 2020, the world generates 41 million tons of carrots and turnips, with China accounting for 44% of this total. Uzbekistan and the United States were two more important producers. (Table 2.4.2.1)

Table 2.4.2.1 Carrots production

Production of Carrots -2020	
Country	Millions of tones
China	18.1
Indonesia	0.7
Japan	0.6
kazakhstan	0.6

Russia	1.4
United states	1.6
Uzbekistan	2.9
World	41
Source: United Nations FAOSTAT, 2020	

Regarding composition, raw carrot is made up of 88 percent of it is moisture, 9 percent is carbohydrates, 0.9 percent is protein, 2.8 percent is dietary fiber, 1 percent is ash, and 0.2 percent is fat. Fiber from carrots is primarily made up of cellulose, with minor amounts of hemicellulose, lignin, and starch. Carrots include fructose, sucrose, and glucose as free sugars (Rubatzky et al., 1999) Carotenoids like -carotene and smaller levels of -carotene, -carotene, lutein, and zeaxanthin give carrots their distinctive, bright orange color (Abdel-Aal et al., 2013) Carotenes and are partially converted to vitamin A, (Strube, 1999), Per 100 gram consumption, carrots offer over than 100 percent of the Daily Value. However, other vital elements are only modestly present in carrots, which are also an excellent source of vitamin B6 (11 percent DV) and vitamin K (13 percent DV) (Novotny et al., 1995), (table 2.4.2.2).

Table 2.4.2.2 Nutritional value of Carrots per 100 gram

Nutrients	Nutrient value	Nutrients	Nutrient value
Energy	173 (41 kcal)	Minerals	
Fat	0.24 g	Zn	0.24 mg
Protein	0.93 g	Na	69 mg
Dietary fiber	2.8 g	K	320 mg
Carbohydrates	9.6 g	P	35 mg
Sugar	4.7 g	Mg	12 mg
Vitamins		Ca	33 mg
Vitamin E	0.66 mg	Fe	0.3 mg
Vitamin k	13.2 µg	Water	88 g
Thiamine (B_1)	0.066 mg		
Riboflavin (B_2)	0.058 mg		
Niacin (B_3)	0.983 mg		
Vitamin (B_6)	0.138 mg		
Folate (B_9)	19 µg		
Vitamin C	5.9 mg		
Vitamin A	835 µg		
Beta carotene	8285 µg		
Source: USDA Food Data base 2018			

2.4.3 Bioactive compounds of Carrots

Carotenoids, polyacetylenes, phenolic compounds, and ascorbic acids are the four main categories of phytochemicals that make up the bioactive components in carrots and contribute to their nutritional value. (Tsao, 2010)

2.5 Benefits of eating fruits and its juice

Fruits contain pleasant flavors, scents, and properties that are healthy for health. Additionally, it offers a lot of dietary fiber, vitamins, and minerals, all of which are good for health. The placenta and fetus both depend on vitamin A for proper growth (Wu et al., 2004). It affects how the skin, mucous membranes, teeth, and retina grow and function.

Fruits are high in iron, thus those who suffer from anemia and pregnant mothers are advised to routinely take them. Consuming fruit can help clear out tight skin pores. Fruit eating is advantageous for people with weak digestion and acidity. Fruits are high in antioxidants and low in carbs. Fruits offer excellent protection against heart disease and other issues due to their high vitamin A (beta-carotene) and E content. Fruits are rich in polyphenol, flavonoid antioxidant chemicals, vitamins, minerals, dietary fiber, and other nutrients (Ara et al., 2014). Fruit has been found to prevent prostate, leukemia, breast, and colon cancers, according to a recent study. Fruits' polyphenolic anti-oxidant components may provide defense against colon and breast cancers, based on various of experimental studies. Additionally necessary for skin and mucous membrane health is vitamin A. It has been demonstrated that eating organic fruits with a lot of carotenes will help prevent lung and oral cancer. Potassium is a crucial element of bodily fluids and cells that help regulate blood pressure and heart rate. Additionally, It provides excellent amounts of vitamin E, vitamin B6 (pyridoxine) and vitamin C. Fruits high in vitamin C assist the body combat damaging oxygen free radicals and build tolerance to pathogenic agents. The creation of GABA hormone in the brain requires vitamin B-6, also known as pyridoxine. Additionally, it regulates blood homocysteine levels, which if left unchecked could damage blood vessels and cause CAD and stroke. Many essential enzymes, such as superoxide dismutase and cytochrome c-oxidase, require copper as a co-factor (Manganese and zinc are additional minerals that work as co-factors for this enzyme). Red blood cell synthesis depends on copper as well (Fowomola, 2010).

2.6 Mixed fruits drinks powder

A drink mix is often referred to as a powdered drink mixed, is a powdered food item that has undergone processing that is typically mixed with water to create a beverage that tastes similar to fruit juice or soda. It gives you the impression of eating fruit straight from the farm. Drink mix has definitely been an important beverage for remote nations. The various nutrients in fruit drink mixes make them appealing. Depending on the brand and product, fruit drink mixes may also contain vitamin A, potassium, and calcium. The best way to start the day is with a glass of fruit drink mix (Willett, 2017).

A particularly concentrated source of fruit sugar is drinks powder made from mixed fruits. This can immediately cause blood sugar to rise. Collagen, a protein that supports healthy skin and cartilage, depends heavily on vitamin C, which is included in mixed fruit drinks powder. Additionally, vitamin C helps maintain healthy hair and joint flexibility. And finally, vitamin C may guard against macular degeneration and cataracts. Your risk of cardiovascular disease may be decreased by taking B vitamins like foliate (Rimm et al., 1998).

Calcium, a mineral that helps maintain healthy bones, is added to the drinks mix powder. Its calcium content may be able to benefit people with their blood pressure, cardiovascular disease risk, and osteoporosis prevention. Additionally, calcium might lessen PMS ramping. By producing osteocalcin, a protein present only in bones, its potassium content may help prevent osteoporosis as well. Juices high in potassium can also lower blood pressure **(**Kumar et al., 2012). Because they are delicious and nourishing for our health, fruit drinks, among other instant beverages, are very well-liked in Bangladesh. Each cup of fruit juice or other fruit-flavored beverage is an excellent amount of vitamins A and C for any diet. The majority of the health advantages of fiber-rich mixed fruit drinks powder included antioxidant protection, protection against arteriosclerosis, and lowered cancer risk. It is a great source of Vitamins C, A (beta-carotene), niacin, quercetin, and potassium. Fruit drinks contain phytochemicals and antioxidants that are extremely helpful in preventing cancer as well as other ailments. Fruit enzymes like mangiferin, catechol oxidase, and lactase clean the intestine of its internal "filth" and are the perfect remedy for any toxic effects on the body. They also offer enough protection to fight off any diseases and bacteria (Masibo and He, 2008).

For kids who are weaning, fruits have been shown to be a healthy complementary diet. With three meals per day plus the FAO's recommended amount of breastfeeding, it meets the vitamin and energy needs of infants aged 6 to 24 months (Gibson et al., 2006).

Although processed fruit juice may not always be safe due to a high concentration of microorganisms and chemical hazards, fruit drinks powder has traditionally been regarded as a healthy beverage. Simple processing techniques are crucial for enhancing the keeping quality in situations when juice preservation is necessary but perhaps only for a little duration, ensuring its safety, nutritional content, and acceptability (Kader, 1983).

2.7 Ingredients for Fruits drinks powder

The fruits drinks mainly consist of following components:

- ☐ Acid source
- ☐ Additives
- ☐ Color Source
- ☐ Flavor source
- ☐ Powders of Natural fruits
- ☐ Sweetening agent
- ☐ Thickening agent

Sweetening agent:

A sugar substitute, often known as a zero-calorie or low-calorie sweetener, is a component of food that tastes sweet like sugar but has a lot fewer calories than sugar substitutes based on sugar (Kroger et al., 2006).

Aspartame (E951)

In some foods and drinks, aspartame (APM), a synthetic, non-saccharide sweetener, is used to replace sugar. It is an odorless, white, crystalline powder made of the amino acids phenylalanine and aspartic acid. It can be used as a tabletop sweetener or in frozen sweets, gelatins, beverages, and chewing gum. It is around 180–200 times sweeter than sugar. Aspartame deteriorates into its component amino acids when cooked or kept at high temperatures. As a result, aspartame shouldn't be used as a sweetener in baking. In somewhat acidic environments, like those found in soft drinks, it is more stable. It may not taste exactly like sugar, but it does not have the same unpleasant aftertaste as saccharin. Aspartame breaks down into its original amino acids when consumed. It is useful for lowering the amount of calories in a product because it is so extremely sweet, that a small amount is required to sweeten a food item (Food and Administration, 2015).

Acesulfame potassium (E950)

Ace K, also referred to as acesulfame potassium, is a sugar replacement (artificial sweetener) that has no calories. Typically, the brands Sunett and Sweet One are used to market it. K is the symbol for potassium. It has a sweetness level 200 times more than sucrose (ordinary sugar), equal to that of aspartame, roughly two thirds that of saccharin, and one third that of sucralose (Agency, 2011).

Glucose

Glucose is mostly utilized to make fructose and meals that contain glucose. It is used in meals as a sweetener, humectant, volume booster, and to produce a softer mouthfeel (Saravanamurugan et al., 2019). Alcoholic beverages are produced by fermenting various sources of glucose into ethanol, such as malt for beer or grape juice for wine. While most other HFCS-sweetened items in the US use HFCS-42, most soft drinks in the US use HFCS-55 (with a fructose level of 55% in the dry mass) (with a fructose content of 42 percent in the dry mass) (US Food and Drug Administration, 2018).

Coloring agent:

Any dye, pigments or chemical that gives food or beverages color when added is referred to as a food coloring or color additive. They come in many different forms, such as pastes, gels, powders, and liquids. Both home and business cooking employ the use of food coloring. Foods contain colorants for a variety of purposes, such as (Khodjaeva et al., 2013):

- To improve the appearance, flavor, enticing factor, and importance of food
- offset color fading brought on by exposure to air, moisture, intense heat, and light

- Truly reflect natural color differences
- Enhance naturally occurring colors
- Make it possible for customers to recognize goods on appearance, such as confectionery varieties or amounts of medications.

Tartrazine

A synthetic lemon-yellow azo dye called tartrazine is largely utilized as a food colour. E number E102 is another name for it (Agency, 2011).

Sunset Yellow FCF

Azo orange dye Oil-based Sunset Yellow FCF, also called Orange Yellow S or C.I. 15985. Its maximum absorption is affected by pH, peaking at 480 nm at pH 1 and 443 nm at pH 13, with a 500 nm shoulder (Codex, 2003). Drugs, cosmetics, and food all include sunset yellow (Robin and Sankhla, 2013). It can be found in confections, beverages, sweets, snacks, sauces, and preserved fruits, for examples.

Beta-Carotene E160

Beta-carotene is a carotenoid isomer that is present in nature. The pigment known as carotene is primarily responsible for the color of many natural items (Milne, 2005). Beta Carotene can be acquired naturally from a variety of edible vegetables, or it can be made artificially from acetone and Blakeslea trispora. Carotenoids from natural and synthetic sources can both be added as coloring agents. Pro-Vitamin A activity is present in all carotenoid forms. Carotenes frequently have yellow to orange tones, yet, they can also be seen in red or orange hues. Carotenoids offer excellent stability to light, heat, and pH (Boon et al., 2010). A variety of foods and beverages, including cheeses, custards, margarines, yogurts, processed nuts, cake fillings, noodles and precooked pastas all include carotenes, a naturally occurring orange food coloring (Joint et al., 2017).

Thickening agent:

A compound known as a thickening agent or thickener can make a liquid viscous without altering its other characteristics. Thickeners may also enhance the suspension of additional ingredients or emulsions, increasing the product's stability. (McClements, 2015).

Xanthan gum

A polysaccharide with industrial uses, including as a typical food ingredient, is xanthan gum. It works well as a stabilizer and thickening agent to keep ingredients from separating (BeMiller and Whistler, 2012).

Carboxymethyl cellulose (CMC)

Carboxymethyl cellulose (CMC), also known as cellulose gum (Vilela et al., 2018), is a cellulose component in which Some of the hydroxyl groups of the glucopyranose units that make up the cellulose substrate are linked to carboxymethyl groups (-CH2-COOH). CMC is a viscosity modifier or thickener that is used in food under the E numbers E466 or E469 (when it is enzymatically degraded) to stabilize emulsions in a variety of goods.

Acid Source:

Food acids are added to flavors to make them "sharper," and they also serve as antioxidants and preservatives. Citric acid, Ascorbic acid, N-hydrate citric acid, malic acid & tartaric acid are examples of common dietary acids (Mirza et al., 2017).

Ascorbic acid

Many foods contain ascorbic acid, generally known as vitamin C, which is also sold as a dietary supplement. It both treats and inhibits scurvy. Vitamin C is an essential nutrient that aids in tissue repair and the enzymatic synthesis of several neurotransmitters. It is necessary for the operation of various enzymes and is essential for the immune system. Additionally, it serves as an antioxidant (Higdon, 2003).

Citric acid

The organic acid citric acid, with the formula $C_6H_8O_7$, is a mild one. It is a natural preservative/conservative that is frequently used in foods and beverages as an acidifier, flavoring, and chelating agent (Additives, 2013; Akther et al., 2020).

Others Ingredients:

Salt

Among the iron salts used as supplements are ferrous sulfate, ferrous gluconate, ferrous fumarate, and ferrous succinate. They function by supplying the iron required to produce red blood cells (Martınez-Navarrete et al., 2002).

Silicon dioxide

Silica is a common ingredient used in the production of food and usually serves as a stream enhancer in dried goods or as an adsorbent for water in humidity uses. It functions as an anti-caking agent in powdered foods like coffee creamer, spices and non-dairy. It is diatomaceous earth's main constituent. As a fining agent for juice, beer, and, colloidal silica is also used (Florke et al., 2008). It bears the reference E551 E number.

Sodium chloride

Table salt is commonly used as a condiment and food preservative in its edible form.

2.8. How to start instant powder Mix Company:

A change in consumer preferences is the main cause of the rising demand for instant powder mix. Traditional quick powder mix is a core part of attractive food products. The promise of better nutrition and an increase in health concerns may be too responsible for this change. Starting an instant powder mix business requires planning for those looking to profit from such a developing market (Akther et al., 2020).

The type of fruits, drinks, and powder goods to sell should be decided by the organizer. The business can also sell energy juice drinks in addition to bottled, freshly squeezed or natural juice. A business plan should be written by the organizer that includes details on the target market, operating costs, marketing strategies, projected profits, public relations tactics, and SWOT evaluation. The SWOT evaluation analyzes the projected business's benefits and drawbacks as well as the opportunities & dangers that exist in the commercial environment. It assists you in identifying and evaluating your competitors' and distributors' sources of fruits, drinks, and powder. The organizer needs to come up with a few instant drink mix powder recipes or look into available quick drink mix powder options. A successful business should be developed by the organizer by providing the market with a unique or original product. A diverse menu can help a firm gain a following. A head start for a new firm can be guaranteed by innovative items and interesting alternatives. Suppliers for the company should be discovered or identified by the organizer. These include produce suppliers for ingredients, wholesalers, and even farmers' markets. Learn how to supply regular ingredients to produce powdered quick drink mixes from fresh fruit suppliers. Citrus, for example, may be the specialty of some providers, while others may offer a wide variety of fruits. For the other materials, the organizer must identify suppliers. The type of pulp to use should be chosen by the organizer. A pulp extractor is used to remove fresh pulp from the fruit prior to making instant drink mix powder. Whether to make instant drink mix powder from fruit or with pulp and other chemical ingredients should be decided by the organizer. The organizer should become familiar with the health licenses necessary for their line of work. By place, these could change. For a firm that deals with food, the government typically demands specific health permissions. BSTI certification, HACCP certification, and food enterprise or distribution licenses are a few examples of mandatory licenses. It is simpler to launch the firm right away if permission procedures are fulfilled. To learn about the licenses necessary to start a retail shop, organizer should get in touch with local officials. A tax identification number, VAT registration, and sometimes a license to sell particular goods are requirements for the organizer. The management, marketing, and production departments of the company should be organized. There should be unique tasks and goals for each unit.

2.9 Microbiological standards for fruit juices and drinks powder

The majority of fruit juices and drink items have enough nutrients to enable microbial development. Several factors, including as hygienic practices and storage, encourage, prohibit, or limit the growth of microbes in drinks, temperature and preservative concentration (Basar and Rahman, 2007).

For the preservation of some fruits' desirable quality, refrigeration or below-freezer storage is not always the best option (Matches and Liston, 1968). Environmental pesticides may also render fruits unhealthy and may contribute to the spread of *Vibrio, Escherichia coli, Shigella, Salmonella and* other infections as well as certain types of fruit deterioration (Doyle et al., 2001). Therefore, infected juices should not be consumed by humans as they pose major health concerns, especially to young children, newborns, the elderly, and people with compromised immune systems (Ahmed et al., 2009).

Table 2.9 Microbiological standards that should be followed for all fruit beverage/juices sold in the Gulf (Gulf Standard 2000).

Test	Total coliforms (cfu/ml)	Total aerobic bacterial count (cfu/ml)	Moulds and Yeast (cfu/ml)
Maximum count expected	10	5.0×10^3	100
Maximum count permitted	100	5.0×10^4	1.0×10^3

Functional foods and nutraceuticals are currently in greater demand on the global market. To retain the nutritional value of these items, their antioxidant properties should be studied. As a result, The goal of this study was to look at the near-term, nutritional, bioactive (polyphenolic and antioxidant components and capacity), sensory, and microbiological characteristics of mixed fruits drinks powder products made from papaya, dry dates, pineapple and carrots.

2.10 Conclusion

Due to their nutritional composition, therapeutic, functional, and industrial features, mixed fruit drinks powder is quite necessary. Because it comprises a variety of fruits, including carrots, papaya, dates, pineapple, it can be consumed daily to meet nutritional needs. Since the drinks powder is made from a variety of fruits, consumers can easily taste the flavors of various fruits in one serving. Mixed fruits drinks powder consider as functional and healthy food due to its health beneficial nutrients like Protein, fat, fiber, CHO, vitamins, minerals and bioactive compounds. By providing the body adequate nourishment, choosing healthy fruits and drinks can boost energy and control appetite.

Chapter III: Materials and Methods

The Department of Applied Food Science and Nutrition, Department of Food Processing and Engineering, Department of Physiology, Pharmacology and Biochemistry, and Poultry Research and Training Center (PRTC) at Chattogram Veterinary and Animal Sciences University conducted research for the formulation and quality assessment of mixed fruit drinks powder from January 1 to May 31, 2022.

3.1. Samples collection

3 kg ripe papaya, 500 g dry dates, 4 pieces pineapple, 2 kg carrots were collected from Jhaotola bazar, Pahartali, Chattogram, Bangladesh.

Figure 3.1 Samples Collection areas (source: Akther et al., 2020)

3.2. Preparation of mixed fruits pulp powder

By using Cabinet drying method, at first freshly collected fruits were free of bug bites and rinsed with water to remove obvious dirt before being blotted dry. The stems and bloom ends of the ripe fruits were removed. The fruits were peeled by hand, the pulp was extracted, and the pulp was blended in a home blender. The pulp was sieved with a 16-mesh sieve before drying to remove big particles. After that, the cabinet drier was filled with the fruit pulp. The cabinet-dried sample was ground and sieved after 3 days to remove big fragments. The production was classified as powdered mixed fruits. As needed for various analyses, a precise quantity was weighed (Akther et al., 2020).

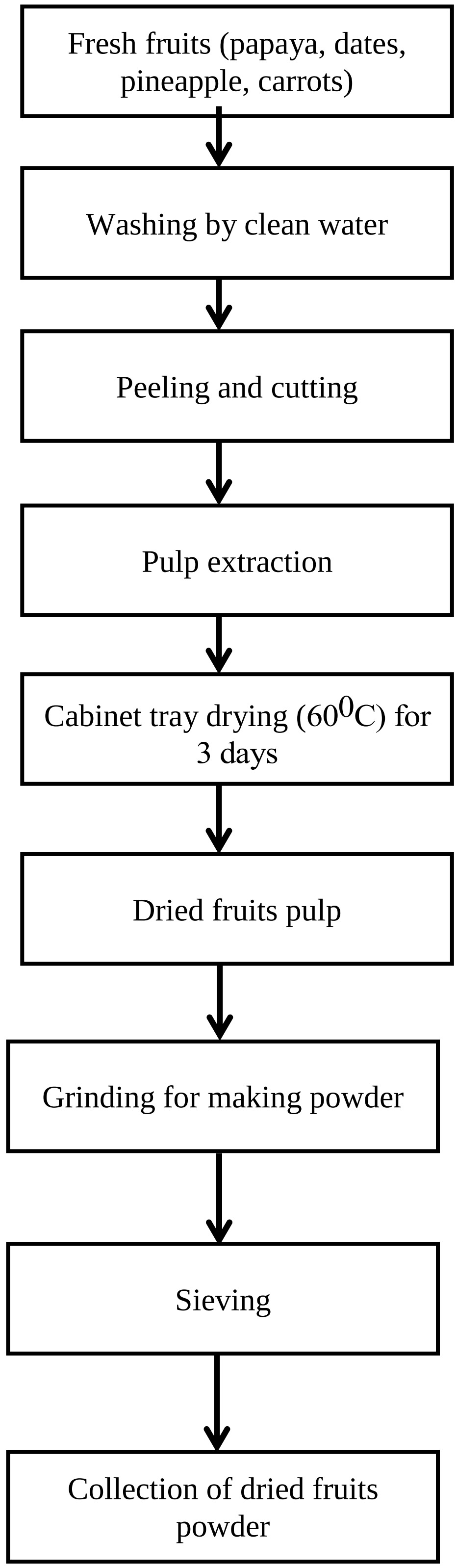

Figure 3.2 Flow Chart of fruits powder processing

3.3 Formulation and processing of mixed fruits drinks powder

To standardize the product, four trials were conducted.

Table 3.3 Formulation of mixed fruits drinks powder (Akther et al., 2020)

Ingredients	Formulation 1	Formulation 2	Formulation 3
Mixed fruits Powder	130g	90g	50g
Citric Acid	11g	11g	11g
Salt	15g	15g	15g
Glucose	70g	70g	70g
CMC	04g	04g	04g
Sugar	300g	300g	300g

All of the ingredients were weighed in accordance with the amounts listed in Table 3.3. Sugar, Citric Acid, Salt, Glucose, CMC, and mixed fruit powder were all combined together. The aforementioned mixture was ground to ensure that the particles were distributed evenly. The sensory evaluation and nutritive content of the mixed fruits drinks powder were carried.

Figure 3.3 Processing of mixed fruits drinks powder

3.4 Proximate analysis of mixed fruits drinks powder

AOAC methods were used to measure the moisture; protein, fat, and ash content of mixed fruits drink powder samples in triplicate. By 105°C thermal treatment to a fixed weight, the moisture content was estimated (AOAC, 2016). The Kjeldahl technique (6.25N) was used to determine the crude protein concentration. The AOAC (2016) method was used to extract total lipid using the Soxhlet device. In a muffle furnace, ash was measured gravimetrically by heating to a constant weight at 550°C (AOAC, 2016).

3.4.1 Moisture/Water

The weight of empty crucibles was dried first, and then 5g of sample was positioned beneath. The crucible was then heated in an air oven for 24 hours at a temperature of 105°C (thermostatically regulated). The crucible was taken out of the oven after dry and put in a desiccator to cool. Then it was weighed using the cover glass. After drying for 30 minutes in the oven again, the crucible was taken out, measured after chilling in a desiccator. Up until the two succeeding weights had equal weights, the drying, cooling, and weighing process was repeated. Using the following weights, the percentage of moisture in food samples was calculated:

$$\%\ Moisture = sample\ weight\ loss\ /Initial\ weight\ of\ sample \times 100$$

3.4.2 Protein

Using the solution, the amount of protein was evaluated: Alkali solution, mixed indicator solution, standard HCl, and digestion mixture (potassium sulfate 100g, copper sulfate 10g, and selenium dioxide 2.5g) are all forms of solutions and combination of indicators (0.1N). To determine the protein content, kjeldahl decomposition flasks were combined with 2 grams of sample, 3 grams of the digestion mixture, and 25 ml of H_2SO_4. It was boiled for four hours in a kjeldahl digestion and distillation apparatus. The material had finished digesting when it turned a light yellow color. Following digestion, a kjeldahl flask holding 10 mL of two percent boric acid and 2 to 3 drops of mixed indicator was filled with 100 milliliter of water, 100 mL of fourty percent sodium hydroxide, and glass rush. Just as the evaporation was ended, 100 mL of distillate were recovered. The collecting beaker was moved such that the distillate was exposed to the head of the distillation tube. To ensure that there were no ammonia remains in the condenser tube, a small amount of distillate was collected using this technique. When the collected ammonia was titrated with a 0.1N HCl solution, titer values were recorded. The percentage of protein in the sample was determined using the protein factor 6.25.

$$\%\ Nitrogen = \frac{(T_s - T_b) \times Normality\ of\ acid \times meq.\ N_2}{Weight\ of\ sample\ (g)} \times 100$$

Where,

T_B = Titer value of Blank (ml); T_S = Titer value of sample (ml); meq. Of N2 = 0.014; % Protein = % Nitrogen × 6.25

3.4.3 Fat

The dried sample was put into a thimble after being measured for moisture and a piece of fat-free parachute was used to seal the thimble's lid. The Soxhlet flask was attached to the tube for fat extract, which was where the thimble was put. Anhydrous ether in the amount of 75mL or more was poured into a flask. The condenser was attached to the fat extraction tube's top. On a water bath at 80°C, It took at least 16 hours to extract the sample. The thimble was withdrawn from the apparatus at the conclusion of the extraction period and distilled or collected in a Soxhlet tube to remove the majority of the ether. The ether was poured out of the tube when it was nearly full. A tiny funnels and cotton pad were used to transfer the ether into a tiny, dry beaker once it had diluted to a minimal volume. The flask was properly cleaned and cleaned with ether. Over a hot bath with less heat, the ether was evaporated and then dries for 1 hour at 100°C, chilled, and weighed. The ether soluble substance in the sample was determined by the weight differential. The presence of fat was indicated by the following:

% Fat = ether soluble materials loss/ weight of sample × 100

3.4.4 Ash

The approved AOAC technique was used to assess the samples' ash content (AOAC, 2003). This approach involves incinerating all organic materials and calculating the weight of the leftover ash. Five grams (5g) of sample were burned for eight hours at 550°C in a muffle furnace with a crucible. The following formula was used to compute it.

% Ash = Weight of ash/Initial sample weight× 100

3.4.5 Crude fiber determination

The AOAC method was used to calculate crude fiber (2005). The water-insoluble portion of carbohydrates known as "crude fiber" is composed primarily of cellulose, hemicellulose, and lignin. By boiling a known amount of fat-free food sample in weak acid solution (1.25 percent H_2SO_4) for thirty min., removing ash from the resulting residue after adding a weak alkali solution (1.25 percent NaOH) for thirty min. at fixed volume., it can be estimated through digestion. This determination was carried out using the Liebig condenser, Reflux condenser, Gooch crucible apparatus and 0.255N Sulphuric acid solution, 10 percent K_2SO_4

solution, and chemicals of the Asbestos-Gooch standard. The weight loss shows crude fiber

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

3.4.6 Total carbohydrates determination

It was defined as the difference between the sum of the other nearby components and the departure from 100. The following equation was used to estimate it as a result (Akther et al., 2020):

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

3.4.7 Energy value determination of mixed fruits drinks powder

By multiplying the samples' protein, carbohydrate, and fat compositions by 4, 4, and 9, respectively, the standard James formula was used to determine their energy content (James, 1995).

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

3.5 Analysis of Minerals

By digesting the organic food matrix, minerals are extracted using this technique. A sample of mixed fruits that had been ground up was digested in an acid solution using a 2:1 mixture of HNO_3 and $HClO_4$In a conical flask, a sample of mixed fruit drink powder weighing 2 gram was measured. Following the addition of 20 ml HNO_3 and 10 ml $HClO_4$, the flask was heated at 200W for 15–20 minutes to ensure thorough digestion. The combination was refrigerated, transferred to a 100 ml standard flask & then mixed to the necessary concentration using distilled water. To determine the mineral content, this solution was utilized. A biochemical analyzer (Humalyzer 3000) was used to determine the mineral contents (sodium, magnesium, potassium, iron, phosphorus, calcium and chloride). For the biochemical assay, a commercially available biochemical kit (Randox) was employed. In mg/dl, all analyses were expressed.

3.5.1 Sodium (Na^+) detemination

Magnesium and uranyl acetate are used to precipitate sodium as a triple salt. A brownish tint results from the reaction of ferrocyanide with excess uranyl ions in an acidic media. The sodium concentration in the sample has an inverse relationship with the color intensity that results. A pipette was utilized to add 0.02 milliliter of sodium standard and one milliliter of the precipitating agent to the cuvette during the precipitation process. The cuvette was filled with 0.02 ml sample and 1 ml of precipitating reagent for the sample. These were thoroughly combined, and after 5 minutes of retention time, they were shaken properly. To get a clean supernatant, these were later centrifuged at 2500 to 3000 RPM. Using a pipette, the color development step involved pouring 0.1 milliliter of color reagent, 0.02 milliliter of precipitating reagent, and 1 ml of blank acid reagent to a cuvette. 1 ml of acid reagent, 0.02 ml of supernatant, and 0.1 ml of color reagent were added to a cuvette to prepare the standard and sample. Then, after combining them, they were incubated at R.T. for 5 minutes. In less than 15 minutes, distilled water was used to test the absorbance of the sample, the standard, and the blank. The concentration of sodium was determined in mmol/L by multiplying the ratio of sample absorbance to standard absorbance by the standard concentration (mg/dl).

3.5.2 Calcium (Ca^{++}) determination

In an alkaline media, calcium ions and O-Cresolphthalein combine to generate a violet complex. A cuvette was filled with 1 ml of working reagent and 25 L of distilled water to generate the reagent blank solution. One milliliter of the working reagent and 25 L of the (Ca++) standard were added for the standard. The sample solution was made by adding 1 ml of the working reagent and 25 µL of the sample extract. Both the sample's and the standard's absorbance were calculated. The concentration of calcium was determined in mg/dl by multiplying the sample absorbance by the standard concentration (mg/dl) (Akther et al., 2020)

3.5.3 Potassium (K^+) determination

A fine turbidity of potassium tetraphenylboron is created when potassium and sodium tetraphenylboron combine. The sample's potassium content has an opposite relation with the sample's turbidity. 1 ml of potassium reagent and 0.02 ml of deionized water were pipetted into the cuvette to create the blank solution. The cuvette was filled with 1 milliliter of potassium reagent, 0.02 milliliter of potassium standard, and 0.02 milliliter of sample extract for the standard solution. Following their mixing, these completed a 5-minute retention period incubation. Within 15 minutes, the absorbance of the standard and sample were measured in comparison to a blank. The potassium concentration was calculated in mg/dl by multiplying the sample absorbance by the standard concentration (mg/dl).

3.5.4 Magnesium (Mg) determination

The method relies on a specific interaction between magnesium and calmagite, a metallochromic indicator, at alkaline pH, which results in a change in the complex's absorb spectral range. The amount of magnesium present in the sample directly affects how intense the cromophore is. To make the reagent blank solution, 1 ml of reagent was obtained and placed in a cuvette. The preparation sample solution was made in a cuvette by adding 1 ml of reagent and 10 mL of sample extract. One milliliter of reagent and ten milliliters of magnesium standard were placed in a cuvette to prepare the standard solution. The cuvettes should sit at room temperature for 2 minutes after mixing. The sample's and the standard's absorption at 520 nm was measured and compared to the reagent blank. The concentration of magnesium was determined in mg/dl by multiplying the sample absorbance by the standard concentration (mg/dl).

3.5.5 Phosphorous (P) determination

1 ml of phosphorus reagent was used to prepare the blank solution, 1 ml of phosphorus reagent, 10 ml of phosphorus standard, and 1 ml of phosphorus reagent, 10 ml of sample extract were pipetted into the cuvette for the sample solution. These were combined and incubated for 5 minutes after that. In comparison to the blank, the sample's and standard's absorbance was measured. The concentration of phosphorus was calculated in mg/dl by multiplying the sample absorbance by the standard concentration (mg/dl).

3.5.6 Chloride ion (Cl^-) determination

Mercuric thiocyanate is converted into thiocyanate when chloride ions interact with free mercuric ions. A reddish-brown ferric thiocyanate complex is created when the released thiocyanate mixes with the ferric ions. The amount of chloride in the sample directly correlates with how intense the color is. 0.01 milliliter of deionized water and 1 ml of chloride reagent were mixed to a cuvette to create the blank solution. For the creation of the basic solution, 1 milliliter of the chloride reagent & 0.01 ml of the chloride standard were taken. For the production of the sample solution, combine 1 milliliter of the chloride reagent with 0.01 milliliter of the sample extract. After mixing, incubate at retention time for 2 minutes. Within 60 minutes, the absorbance of the standard and sample were measured against a blank. By multiplying the standard concentration (mg/dl) by the ratio of sample absorbance to standard absorbance, the chloride concentration was calculated in mmol/L.

3.5.7 Iron (Fe) determination

In a mildly acidic media, the transferring-iron compound is broken off from the iron. Ascorbic acid was used to convert liberated iron into the bivalent form. With Ferrozine, ferrous ions produce a colorful complex. The amount of iron present in the sample directly correlates with the intensity of the color those results. With the aid of a pipette, 1 ml of reagent was added to the cuvette to create the blank solution. 1 ml of reagent and 200 µL of standard were added for standard production. For the production of the sample solution, 200 µL of sample extract and 1 ml of reagent were added. After mixing, 10 minutes were spent incubating the sample solution at ambient temperature. Measurement of standard and sample absorbance in comparison to a blank, Iron concentration was measured in µg/dl.

3.5.8. Vitamin C determination

Using a solution of 2, 6-dichlorophenol indophenol dye, Using the titration technique, the ascorbic acid concentration of persimmon was evaluated (Ranganna, 1986). It is quantified by reducing the 2, 6-dichlorophenol indophenol dye to a neutral state in an alkaline solution of ascorbic acid. For ascorbic acid in solutions with pH values ranging from 1.3 to 3.5, the reaction is measurable and extremely specific. The dye solution was initially calibrated against a standard ascorbic acid concentration in the process that followed. After diluting the sample with 3 percent metaphosphoric acid, the phosphoric acid extract was titrated against the dye solution until a 15-second pink hue was produced. The dye factor was calculated using the equation below:

Dye factor = 0.5/ Titrate vol.

The following was used to calculate ascorbic acid, which was calculated as mg of ascorbic acid per ml:

mg of ascorbic acid / ml = titrate vol. (ml of dye used) × dye factor × vol. made up × 100 / aliquot of sample taken for estimation × vol. of sample.

3.5.9. Vitamin A determination

Utilizing a colorimeter, vitamin A was measured. The overall Vitamin A content of a particular food is calculated using both retinol and beta carotene contributions. Retinol and carotenoids are extracted into light petroleum and combined with alcohol to precipitate proteins. Before performing the color reaction, the light petroleum is vaporized and the remainder is mixed in chloroform after being informed of the carotenoid-caused yellow color's intensity. The reaction's contribution from the carotenoid is taken into account (Bradley and Hornback, 1973). Retinol in the samples undergoes a reaction with trifluoroacetic acid (TFA). The sample and TFA reaction exhibit a blue tint, indicating the amount of retinol in the sample. The blue hue is ephemeral, therefore if it appears, it must be seen within two seconds after introducing the reagent (Guamuch et al., 2007). Using a vortex mixer, 100 mg of each sample preparation was combined with 1 milliliter of distilled water and 2 ml of ethanol in a tube. 1 cc of the supernatant was removed after the tube had been centrifuged for 15 minutes at 3000 rpm. Carotene was discovered first. S2 reagent (6 ml) was used to prepare the blank solution, and standard reagent (6 ml) was pipetted into the cuvette for standard preparation. 1 milliliter of sample extract, 2 milliliter of S1 reagent & 3 milliliter of S2 reagent were pipetted into a cuvette to prepare the sample solution. For ten minutes, all were thoroughly blended using a vortex mixer and a mechanical shaker. During the 10-minute centrifugation, the tubes were spun at 3000 RPM. With 2 ml of sample supernatant, standard, and blank, the intensity was then determined at 420 nm in contrast to the blank. To stop the solvent from evaporating and the light from destroying the carotenoids, this was done right away. The retinol was then identified. To make the sample solution, 2 ml of the sample extract used to determine the amount of carotenes was taken, and the contents of the sample cuvette were dried out in a water bath heated to 50 °C. The sample cuvette was then filled with 100 µl S4 reagent and 1 ml S5 reagent once 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. 100 µl of standard reagents and 1 ml of S5 reagent were used to prepare the standard solution. Using a vortex mixer, these were well blended. Because S5 reagent is a potent acid with an irritating vapor, the absorbance was measured at 620 nm exactly 2 seconds after the addition of the reagent. Following are the measurements for the amount of carotene, retinol, and total vitamins:

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

Retinol (mg/l) = (0.0759 × Absorbance) + 0.1023

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)

3.6 Bioactive compounds of mixed fruits drinks powder

3.6.1 Extracts Preparation

A modified approach presented by was used to ascertain the identity of phenolic acids (Ferreres et al., 2008). A shaker was used to stir samples of mixed fruits drinks powder for 72 hours at room temperature in beakers containing 100 percent ethanol. After that, straining was used to separate the solvent from the residue. While the residue was twice more extracted with new solvent each time, the supernatant was saved and stored at ambient temperature. All of the filtrates were combined, and then a rotary evaporator was used to evaporate them all decreased at 60 °C pressure to produce the chemical extracts. Weighed filtrates were kept at 4°C for additional analysis.

3.6.2 Total anthocyanin content (TAC)

The method described will be used to calculate the calorimetric TAC of the mixed fruit drink powder extract with a few minor modifications (Selim et al., 2008). 15 mg/mL extract stock solutions will be created. Pipette 3 mL of the extract solution into a sample cell. The UV-VIS spectrophotometer will be used to gauge the extract's color intensity at 520 nm. A control substance will be ethanol. The following equation will be used to compute and represent TAC as milligrams per 100 grams (mg/100 g):

TAC = Sample absorbance×DF×100/m×E

Where, m denotes the sample weight used to create the stock solution, DF denotes the dilution factor and E denotes the extinction coefficient (55.9).

3.6.3 Total flavonoid content (TFC)

The aluminum chloride colorimetric technique will be used to determine the TFC of the powder extracts of mixed fruits drink (Chang et al., 2002). Extract remedy containing (1 mg/ml) will be made. To create standard solutions (1.0, 3.0, 5.0, and 7.0 mg/ml) for the purpose of plotting a standard curve, quercetin will be dissolved in 80% ethanol. In the cuvette, combine aliquots of 0.5 ml diluted extract or standard solution with 1.5 ml 95% ethanol, 0.1 ml aluminum chloride, 0.1 ml potassium acetate, and 2.8 ml distilled water. The combination will be kept at room temperature for thirty minutes. At a wavelength of 415 nm, the absorbance will be measured in a UV-visible spectrophotometer. The equivalent volume of distilled water will be used in place of the blank's 10% aluminum chloride. TFC is expressed as mg QE/g, or milligrams of quercetin equivalents, per gram of extract.

3.6.4 Total phenolic content (TPC)

The procedure described will be slightly modified in order to determine the TPC of powder extracts of mixed fruit drinks (Azizi et al., 2010). Gallic acid basic solutions (1.0, 2.0, 4.0, 6.0, and 8.0 milligram/ml) and extract standard solution (1 mg/mL) will be created. In a cuvette, pipette extracts or 0.3 mL of standard gallic acid solution. Then, 1.5 mL of diluted FC solution will be poured and combined. After pouring 1.5 mL of sodium carbonate (75 g/L) solution, the mixture will be allowed to sit for 60 minutes. To test the absorbance at 765 nm, a UV spectrophotometer was employed, with ethanol serving as the blank. TPC content is measured in milligrams of gallic acid equivalents (GAE) per gram of extracts, or mg GAE/g.

3.7. Antioxidant properties of mixed fruits drinks powder

3.7.1 DPPH assay

Using a slightly modified version of the DPPH test, the extracts' antioxidant potential was assessed (Azlim Almey et al., 2010). A stock extract solution containing 1 milligram/ml was mixed in methanol to concentrations of 0.50, 1.00, 1.50, 2.00, and 2.50 mg/mL. To create a methanolic DPPH solution, 100 mL of methanol were used to dissolve 6 mg of DPPH. The absorbance at 517 nm wavelength was calculated by adding a methanolic DPPH solution (2 ml) to 1 mL of every extract with varying concentrations. The control was created using 2 ml of the DPPH solution and 1 ml of methanol. Trolox served as the reference, and methanol served as the blank. The antioxidant capacity of extracts was measured in milligrams of Trolox equivalent (TE) per gram of extracts (mg TE/g), which was based on their capacity to scavenge DPPH free radicals.

3.8. Microbiological analysis of the mixed fruits drinks powder

The samples were examined bacteriologically at the QC Lab of Mart Promoters, located at 4 Zakir Hossain Road in South Khulshi, Chattogram, Bangladesh, and BCSIR Baluchora, khagrachori Road, Chattogram, Bangladesh.

3.8.1. Total viable count

A total viable count was done according to (FAO 1997) using plate count agar (Oxoid, CM 0325). Using a vortex mixer (VM-300, Taiwan), 1 ml of the mixed fruits drink powder sample was combined with 9 ml of sterile peptone water to create the first dilution. Pour-plated in duplicate, 1 ml of a chosen dilution's sample was incubated 37 °C for 24 hours. Using a computerized colony counter, bacteria were enumerated and the results were expressed as colony forming units per milliliter (CFU/ml).

3.8.2. Total coliform count

Standard Methods were followed for the total coliform count. The medium was produced as directed by the manufacturer. Each test tube had 10 ml of lactose broth distributed evenly among them (9 test tubes), which was then properly sterilized for 15 minutes at 121 °C and incubated at 37°C overnight to check for contamination. Next, each test tube received 10 ml of a 10:1:0.1 ratio samples, which was incubated 24 hours at 37 °C. Coliform positive or negative gas was produced when the hue has been altered.

3.8.3. *E. coli*

The standard method was used to prepare E. coli, the test component, the original suspension as well as the necessary quantity of dilutions. As a verification medium, screw cap tubes with reversed Durham tubes were made with double- and single-strength Lauryl sulfate tryptose broth, EC broth, and brilliant green lactose bile broth. The test sample or beginning suspension was then injected into 3 test tube of a double and single-strength liquid selective media culture and the tubes were incubated for 24 or 48 hours at 30°C or 37°C. The cultures from the double- and single-strength selective enrichment medium tubes where gas generation or opacity inhibiting the identification of gas formation occurred were put into a series of confirming medium tubes. The quantity of tubes in the new series that showed gas generation was used to estimate the MPN, or the most likely quantity of coliforms per gram or per milliliter of material. The most probable numbers were determined using a table (Feng et al., 2002).

3.8.4. Yeast and mold count

According to FAO (1997) guidelines, a yeast and mold count was conducted. Saborauad Dextrose Agar (Hi media, M096) was made according to the manufacturer's instructions (Boylan et al., 2001). The mixture was then placed onto a Petri plate and let to incubate overnight to check for contamination. 1 ml of homogenized sample was obtained and plated in duplicate on SDA medium. The outcome was expressed as whether or not yeast and mold development was present.

3.9. Organoleptic evaluation

Prepared mixed fruits drinks powder (A=Formulation 1, B=Formulation 2 and C=Formulation) were subjected to sensory evaluation by 10 persons. The panelists were made up of both male and female members, as well as CVASU students with prior expertise evaluating juice and drink items. A score card was created specifically for the purpose of evaluating mixed fruit drinks. The quality attributes of the products were taken into account when creating the score card. The descriptive names of several quality traits, including appearance/color, odor, taste and overall acceptance were used. The experiment was conducted in a lab at room temperature in the department of food processing and engineering at Chattogram Veterinary and Animal Sciences University (CVASU). Each panelist rated samples on their own and entered their results on the provided score sheets.

The scale was 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. While scoring, the most desired characteristic received the greatest score (9) and the least desired characteristic received the lowest score (1). Of course, although this method may not accurately reflect user perception, it strongly suggests qualities that a high-quality product ought to have.

3.10. Data analysis statistical tools

Data (proximate composition, bioactive compounds, vitamin and minerals content and sensory analysis) were determined & preserved in a 2013 Microsoft Excel spreadsheet for statistical evaluation to analyze statistical analysis. Each sample was replicated three times. Descriptive data analysis (mean, standard deviation) were employed to analyze the proximate composition, vitamin and mineral contents of all samples, bioactive ingredients, and sensory evaluation of mixed fruit drink powder. Using IBM SPSS Statistics 16, the data was organized, coded, and recorded. After that, a statistical analysis was performed. To assess the proximate composition, trace minerals, bioactive chemicals and sensory assessment data in to determine the significant level of variation at the 95 percent confidence interval, one-way ANOVA techniques had been used. Using a post hoc "Tukey" test, the variation within the sample groups was determined. The significance limit used in the statistical analysis was 5% (P less than 0.05).

Chapter IV: Results

4.1 Proximate analysis of mixed fruits drinks powder:

Table 4.1 displayed the approximate content of three powdered mixed fruit drinks (ME±SD= Mean± Standard Deviation). Formula A, B, C had the similar moisture content (4.9±0.66) %, (4.9±0.59) % and (4.9±0.61) %. These three formulations don't significantly differ from one another. The highest score of ash content (3.6±0.04) % was found in the formula B and the lowest score (3.5±0.01) % was for formula A and C. The ash composition of these three formulations didn't differ noticeably from one another. Protein and crude fat are less abundant in fruit and vegetables. Protein content was higher (1.4±0.03) % in formula A whereas lower value (1.0±0.04) % was found in formula C. Carbohydrate content (88.0±0.53) % was higher in the formula B comparatively than formula A & C. In case of Energy, formula C scored the highest value (377.0±2.42) (Kcal/100g) and the lowest value (367.6±2.28) (Kcal/100g) was scored by formula A. In table 4.1 A, B & C represented Formulation 1 (25% mixed fruits powder), Formulation 2 (18% mixed fruits powder), Formulation 3 (11% mixed fruits powder) respectively. In one-way ANOVA procedures, descriptive statistics and the Post hoc Tukey test were used to statistically assess the data at the 5% level of significance.

Table 4.1 Proximate analyses of mixed fruits drinks powder

Formulas	Moisture (%)	Ash (%)	Fiber (%)	Protein (%)	Fat (%)	CHO (%)	Energy (Kcal/100g)
A	4.9 ± 0.66^{a}	3.5 ± 0.02^{a}	1.1 ± 0.06^{a}	1.4 ± 0.03^{a}	1.3 ± 0.02^{b}	87.5 ± 0.63^{a}	367.6 ± 2.28^{b}
B	4.9 ± 0.59^{a}	3.6 ± 0.04^{a}	0.9 ± 0.05^{b}	1.1 ± 0.03^{b}	1.2 ± 0.05^{c}	88.0 ± 0.53^{a}	367.8 ± 2.02^{b}
C	4.9 ± 0.61^{a}	3.5 ± 0.01^{a}	0.5 ± 0.04^{c}	1.0 ± 0.04^{c}	2.6 ± 0.02^{a}	87.3 ± 0.60^{a}	377.0 ± 2.42^{a}

** Comparison across formulations; scores represented by different superscript letters indicate a noticeable difference; significant at $P < 0.05$.

Where, A = Formulation 1 (25% mixed fruits powder), B = Formulation 2 (18% mixed fruits powder), C = Formulation 3 (11% mixed fruits powder)

Every value displayed the ME±SD of the data, where ME stands for Mean and SD for Standard Deviation.

4.2 Bioactive compounds of mixed fruits drinks powder

Table 4.2 showed (ME±SD) of bioactive compounds of three formulated mixed fruits drinks powder. Formula B contained the most anthocyanins overall (TAC) 153.3±0.32 (mg/100 g) whereas formula A had the lowest score 149.4±0.32 (mg/100 g). The highest value of total flavonoid content (TFC) 35.4±0.16 (mg QE/100 g) was found in the formula A and the lowest value 11.6±0.04 (mg QE/100 g) was for formula C. In formula B, the total phenolic content (TPC) was higher 4.6±0.00 (GAE mg/100 g) whereas lower value 4.3±0.00 (GAE mg/100 g) was found in formula A. Antioxidant Capacity content 2.7±0.00 (mg TE/100 g) was higher in the formula A comparatively than formula C 2.1±0.00 (mg TE/100 g). In table 4.2 A, B & C represented Formulation 1 (25% mixed fruits powder), Formulation 2 (18% mixed fruits powder), Formulation 3 (11% mixed fruits powder) respectively. In one-way ANOVA procedures, descriptive statistics and the Post hoc Tukey test were used to statistically assess the data at the 5% level of significance.

Table 4.2 Bioactive compounds of mixed fruits drinks powder

Formulas	TAC (mg/100g)	TFC (mg QE / 100 g)	TPC (mg GAE / 100 g)	AC (mg TE / 100 g)
A	149.4±0.32^{c}	35.4±0.16^{a}	4.3±0.00^{b}	2.7±0.00^{a}
B	153.3±0.32^{a}	19.8±0.26^{b}	4.6±0.00^{a}	2.4±0.00^{b}
C	151.5±0.00^{b}	11.6±0.04^{c}	4.4±0.00^{a}	2.1±0.00^{c}

** Comparison across formulations; scores represented by different superscript letters indicate a noticeable difference; significant at P <0.05.

Where, A= Formulation 1 (25% mixed fruits powder), B= Formulation 2 (18% mixed fruits powder), C= Formulation 3 (11% mixed fruits powder).

Every value displayed the ME±SD of the data, where ME stands for Mean and SD for Standard Deviation.

4.3 Mineral contents of mixed fruits drinks powder

Table 4.3 showed the mineral contents of three formulated mixed fruits drinks powder. Magnesium, Potassium, Phosphorus Chloride and Calcium were higher in formula A. Sodium was higher in formula B. Iron was found almost similar in all the formula. The Potassium, Calcium and Phosphorus content of formula B and formula C were similar. Lowest Sodium was found in formula A. Lowest Magnesium was observed in formula C and lowest Chloride was observed in formula B.

The highest Sodium, Potassium, Calcium, Magnesium, Chloride, Phosphorous, Iron were (397.8±0.01) mg/dl, (9.4±0.02) mg/dl, (3.4±0.01) mg/dl, (0.7±0.01) mg/dl, (23.4±0.01) mg/dl, (2.8±0.01) mg/dl, (0.1±0.00) mg/dl respectively and the lowest values were (365.4±0.01) mg/dl, (5.4±0.02) mg/dl, (2.1±0.01) mg/dl, (0.3±0.01) mg/dl, (16.7±0.01) mg/dl, (1.4±0.01) mg/dl, (0.0±0.00) mg/dl respectively.

Table 4.3 Mineral contents of mixed fruits drinks powder

Formulas	Na (mg/dl)	K (mg/dl)	Ca (mg/dl)	Mg (mg/dl)	Cl (mg/dl)	P (mg/dl)	Fe (mg/dl)
A	365.4 ± 0.01^{c}	9.4 ± 0.02^{a}	3.4 ± 0.01^{a}	0.7 ± 0.01^{a}	23.4 ± 0.01^{a}	2.8 ± 0.01^{a}	0.1 ± 0.00^{a}
B	397.8 ± 0.01^{a}	5.4 ± 0.02^{b}	2.3 ± 0.01^{b}	0.4 ± 0.01^{b}	16.7 ± 0.01^{c}	1.4 ± 0.01^{b}	0.1 ± 0.00^{a}
C	388.8 ± 0.02^{b}	5.4 ± 0.02^{b}	2.1 ± 0.01^{b}	0.3 ± 0.01^{c}	18.2 ± 0.01^{b}	1.6 ± 0.01^{b}	0.0 ± 0.00^{a}

** Comparison across formulations; scores represented by different superscript letters indicate a noticeable difference; significant at P <0.05.

Where, A= Formulation 1 (25% mixed fruits powder), B= Formulation 2 (18% mixed fruits powder), C= Formulation 3 (11% mixed fruits powder).

Every value displayed the ME±SD of the data, where ME stands for Mean and SD for Standard Deviation.

4.4 Vitamin contents of mixed fruits drinks powder:

In the citrus fruits vitamin C in found in higher amount. In our formulation we used pineapple which is a citrus fruit. We also added Papaya, Carrots and Dates which also contain high amount of Vitamin A. Vitamin A are mostly found the colorful fruits. In table 4.4 the vitamin C and vitamin A of the three formulas were presented. We can see that formula A and formula B were almost similar in vitamin C content. But among them formula B had the highest amount of vitamin C (16.7±0.01 mg/dL). The lowest vitamin C (11.7±0.01 mg/dL) was in the formula C. The highest vitamin A (462.1±0.03 µg/100g) was observed in the formula A and the lowest was observed in the formula B (434.2±0.04 µg/100g).

Table 4.4 vitamin content of mixed fruits drinks powder

Formulas	Vit-C (mg/dl)	Vit-A (µg/100g)
A	15.0±0.01[a]	462.1±0.03[a]
B	16.7±0.01[a]	434.2±0.04[c]
C	11.7±0.01[b]	436.5±0.01[b]

** Comparison across formulations; scores represented by different superscript letters indicate a noticeable difference; significant at P <0.05.

Where, A= Formulation 1 (25% mixed fruits powder), B= Formulation 2 (18% mixed fruits powder), C= Formulation 3 (11% mixed fruits powder).

Every value displayed the ME±SD of the data, where ME stands for Mean and SD for Standard Deviation.

4.5 Microbiological evaluation of mixed fruits drinks powder

Microbiological features are indicators of the prepared mixed fruits drink powder's safety, quality, and shelf life. At 0, 30, 60, and 90 days, the fiber-rich mixed fruits drinks powder's total Coliform, E. coli, viable count, mold and yeast counts were analyzed. The outcomes are displayed in the table 4.5.

Table 4.5 Microbiological Evaluation of the mixed fruits drinks powder

Formulas	TVC				TCC	E. coli	Yeast & Mold
	0	30	60	90			
A	1.5×10^2	1.3×10^3	2.1×10^3	1.3×10^4	ND	ND	ND
B	1.6×10^2	1.0×10^3	2.5×10^3	1.4×10^4			
C	1.4×10^2	1.2×10^3	2.2×10^3	1.2×10^4			

Where, A= Formulation 1 (25% mixed fruits powder), B= Formulation 2 (18% mixed fruits powder), C= Formulation 3 (11% mixed fruits powder). TVC= Total Viable Count; TCC= Total Coli form count; ND= Not Detected

Table 4.5 provides information regarding the coliform count, total viable count, total yeast and mold count in the mixed fruit powder drinks formulas A, B, and C. Following the manufacturing of mixed fruits drinks powder, each sample was counted at 0, 30, 60, and 90 days of storage. Total viable count was always found, however total coliform, *E. coli*, yeast, and mold were not found.

4.6. Sensory evaluation of mixed fruits drinks powder

Based on the trail with the highest scores for all sensory qualities and overall acceptability will chose as the optimum standard formula for product development, In table 4.6 highest (ME±SD) scores for color were recorded (7.1±1.59) in case of formula A. The highest acceptance of flavor, taste and general acceptance were recorded in formula B (7.1±0.73), formula A (7.2±1.03) and formula A (7.1±1.72) respectively. Although the flavor and the texture were almost statistically similar in all the samples, the overall acceptability was observed in formula A (7.1±1.10).

On the other hand, lowest scores for color were recorded (7.0±0.81) for formula B. lowest flavor and texture were recorded in formula C (6.9±0.94) and formula C (7.0±0.81) respectively. For general acceptance lowest value was scored for formula C (6.7±0.67).

Table 4.6 Sensory quality of mixed fruits drinks powder

Formulas	Sensory attributes				
	Color	**Flavor**	**Texture**	**Taste**	**Overall acceptability**
A	7.1 ± 1.59^{a}	7.0 ± 0.94^{a}	7.2 ± 1.03^{a}	7.1 ± 1.72^{a}	7.1 ± 1.10^{a}
B	7.0 ± 0.81^{a}	7.1 ± 0.73^{a}	7.1 ± 0.73^{a}	7.0 ± 0.94^{ab}	6.9 ± 0.73^{ab}
C	7.0 ± 0.94^{a}	6.9 ± 0.94^{a}	7.0 ± 0.81^{a}	6.9 ± 0.87^{ab}	6.7 ± 0.67^{bc}

** Comparison across formulations; scores represented by different superscript letters indicate a noticeable difference; significant at $P < 0.05$.

Where, A= Formulation 1 (25% mixed fruits powder), B= Formulation 2 (18% mixed fruits powder), C= Formulation 3 (11% mixed fruits powder).

Every value displayed the ME±SD of the data, where ME stands for Mean and SD for Standard Deviation.

Chapter V: Discussions

5.1 Proximate analysis of mixed fruits drinks powder

Additionally, the moisture level of the mixed fruit drinks powder was a little bit higher as compared to the data from other studies (Akhter et al., 2010; Mahendran, 2011). Even though increased moisture promotes the growth of bacteria, which eventually degrades attributes, controlling food's water content is essential. Microorganism growth is significantly influenced by moisture content. When the moisture content is less than 8%, microorganisms cannot develop. However, some microbes may slowly multiply when moisture content is above 18 percent. Additionally, according to (El Wakeel, 2007), for dried materials, water level of less than 10 percent is preferred for maintaining the quality of instant drink powder. The ash content of all currently designed powdered mixed fruit drinks was discovered to be greater than in other studies' results (Akhter et al., 2010; Mahendran, 2011). Our findings are further confirmed by study into (Mohammed et al., 2017). All formulated mixed fruit drinks powder has a higher ash content, which may indicate that they provide better mineral content. The protein content the mixed fruits drinks powder was viewed by other researchers (Akhter et al., 2010) and (Chandramouli et al., 2012; Rao et al., 2012; Farzana et al., 2017; Mohammed et al., 2017). The table 4.1 shows that the powdered mixed fruits drinks are better than other choices in most areas. The fat level of each powdered mixed fruit drink was approximately the same. The fat level of the currently available powdered mixed fruit drinks was found to be lower than that of the findings of other studies (Rao et al., 2012; Mohammed et al., 2017) and similar than (Akhter et al., 2010; Chandramouli *et al.*, 2012). The body's inside organs such as the lungs, kidney, heart and subcutaneous skin cells, are protected by fat. The body stores fat as a concentrated form of energy that can be used when the body requires an energy boost in general (Mohammed et al., 2017).The fiber content of presently formulated mixed fruits drink powders was found that was not found in research study (Akther et al., 2020). The findings of previous studies revealed that the carbohydrate content of all currently formulated powdered mixed fruits drinks was higher (Chandramouli et al., 2012; Farzana et al., 2017). The all-formulated mixed fruit drinks powder has excellently high carbohydrate content, indicating that it is a reliable source of energy. All powdered mixed fruits drinks have lower energy content. All mixed fruit drinks powder's reduced energy value may be caused by its lower fat and carbohydrate content. The mixed fruit drinks powder is safe for human consumption, according to the findings of the proximate study. Since proximate analysis is used to assess the nutritional, microbiological and sensory qualities of food products and raw materials, its importance in development of food items doesn't need to be emphasized. It serves as the foundation for food product formulation, is still the only way to maintain and monitor food quality standards, and may therefore be used to assess and monitor food product shelf life. (Johnson and Raymond, 1965).

5.2 Bioactive compounds of mixed fruits drinks powder

The total bioactive components in each of the powdered mixed fruit drinks were found to be different. All of the powdered mixed fruit drinks were found to have higher total anthocyanin, total flavonoid, and total phenolic contents. Since the daily dietary intake of polyphenolic compounds was found to be between 0.15 and 1.0 g (Akther et al., 2020), the studied all-formulated mixed fruit drinks contain significant total phenolic concentrations that may help to increase the amount of antioxidants consumed by humans. Table 4.2 displays the DPPH assay results for the mixed fruit drink powder sample's antioxidant capability. Based on the DPPH assays, Formulated A showed highest antioxidant capability of any sample. Results indicated that following powder processing, antioxidant capacity has decreased. The majority of the antioxidant components were lost during the heat treatment used in the manufacture of the powder product in the current study. The Folin-Ciocalteu technique was used in the current study to determine the sample's total phenolic content. It is crucial to note that the reducing agents included in food, such as ascorbic acid, sugars & others can interfere with the Folin-Ciocalteu assay, which could cause it to overestimate the concentration of phenolic compounds.

5.3 Vitamin & mineral contents of mixed fruits drinks powder

In order to keep the human body functioning properly and in good health, vitamins and trace elements are crucial. Due to the weakened immune system, inadequate dietary intake of minerals and vitamins is frequently linked to an increased susceptibility to infectious diseases. In this study, there were substantial differences in the amounts of vitamin C, A, and trace components in all of the drinks powder made with mixed fruits. The vitamin C concentration of the powdered drinks made entirely of mixed fruits significantly less than that of the other studies (Ositadinma et al., 2015; Akther et al., 2020*)* and the vitamin A content was higher than the other studies report (Gebhardt et al., 2013; Adelekan et al., 2014; Ositadinma et al., 2015) Table 4.4. The addition of mixed fruit drinks powder, which is a strong source of vitamin A, may be the cause of the rich in vitamin A concentration. In table 4.3, the minerals content in which sodium, potassium was found higher in the presently all formulated mixed fruits drinks powder and other minerals was found similar than that of other studies results (Farzana et al. 2017; Akther *et al.,* 2020). The relative percentage of dry matter content may have increased, which would explain the gradual decrease in moisture content (Brouwer, 1962).

5.4 Microbial analysis of mixed fruits drinks powder

Microbiological testing for the powdered mixed fruits drinks A, B, and C was also done in this study. Total Viable Count (TVC), isolation of bacterial count, yeast, and mold development were all examined at 0, 30, 60, and 90 days following the processing of mixed fruit drinks powder. Maximum moisture content for the items during storage for up to two months was 4.9 percent, which was not a favorable environment for microbial development. Microbial analysis was not done because of this. According to Food Standards New Zealand and Australia (2001), the total counts of yeast, mold, and aerobic platelets were all below the allowable limits, but that no E. coli or Coliform were discovered 3 month. After six months, the sanitary indicator organisms steadily grew and the product's quality began to deteriorate.

5.5 Sensory evaluation of mixed fruits drinks powder

When the mixed fruits drinks powder is mixed with water, it produces the authentic taste of fresh farm juice. During the summer, mixed fruit drinks are a popular choice of beverage due to their delicious fruit flavor and nutritious benefits. Sensory characteristics of all formulated mixed fruits drinks powders showed that the overall acceptability of the formula A got the hedonic scale like moderately. Sensory features of all formulated mixed fruits drinks powders revealed that the overall acceptability of the formula A was moderate. Sensory ratings of designed mixed fruits drinks powder were found to be highly acceptable in this study in terms of flavor, taste, color & overall acceptability.

Chapter VI: Conclusion

The production of mixed fruits drink powder is an extraordinary value-added product, according to this study, and it is also observed to have acceptability according to appearance, texture, flavor and taste. The product's nutritious composition was also desirable from a health standpoint. The new drinks powder has a high marketing potential. Based on biochemical and sensory evaluations, the produced mixed fruits powder is comparable to all other powder drinks accessible locally. Because of the low moisture content, the mixed fruits drink powder has a longer shelf life. From a microbiological standpoint, this mixed fruits drink powder is safe to consume for up to 6 months. It's also worth noting that this powder has precise levels of calories, salt, potassium, calcium, magnesium, iron, phosphorus, chloride, fat, protein, ash, fiber, vitamin C, and vitamin A, currently making mixed fruits drink powder an excellent choice for meeting the country's nutritional needs. This has the potential to significantly reduce our country's malnutrition.

Chapter VII: Recommendations & future perspectives

Fruits like pineapple, papaya, dates, and carrots are a crucial and healthy part of a person's diet since they include bioactive chemicals that are helpful for maintaining good health as well as vitamins and minerals. This study's goal is to examine the creation process and evaluation of the mixed fruit drink powders manufactured from papaya, pineapple, dates, and carrots (nutritional, chemical, microbiological, bioactive compounds, sensory). In rural locations without complex processing facilities, this strategy is simple to adopt. By setting up a small-scale processing device at the producer level, it would be possible to use the fruits to create powders for mixed fruit drinks, allowing growers to purchase this product throughout the year and minimizing post-harvest losses while still producing income. The following recommendations and suggestions for further studies are provided in light of the current study:

- Zinc and manganese are among the mineral components of mixed fruit drink powder that should be analyzed.
- Analysis of fat-soluble vitamins like D, E, and K is necessary.
- The results have therapeutic relevance and will be useful from that perspective.
- The composition could be changed to have a different flavor for improved flavor.
- It is important to raise awareness of the potential for the food sector as well as the health advantages of drink powder made from mixed fruits.
- Costing should be determined.
- Modern packaging and storage techniques would be created to improve fruits product quality.

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Appendices

Appendices A: Photo Gallery

Appendix A1: Pictorial presentation of processing of mixed fruits drinks powder

Fruits (PDPC) peeling and Cutting

Tray

Drying

Dried fruits

Grinding and preparing fruits powder

Ingredients

Mixing

Mixed fruits drink powder

Appendices A: Photo Gallery

Appendix A2: Pictures of laboratory activities

Weighing

Standard solution

UV-visible

Sampling

Moisture

Protein

Fat

Fiber

Ash

Minerals

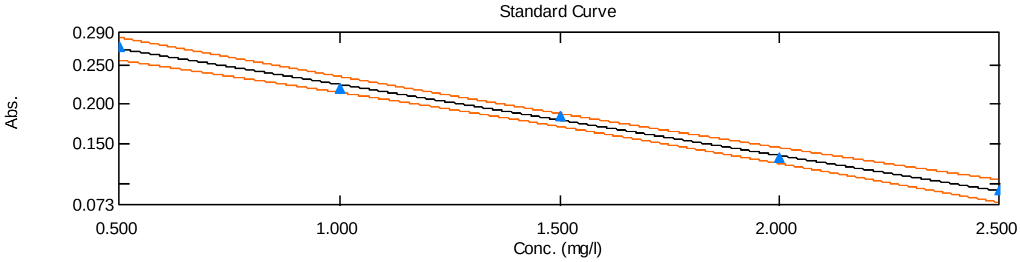
Microbiological

Appendix B: Standard Curve and Sample curve for bio active compounds

Antioxidant Capacity Standard Table:

Sample ID	Type	Ex	Conc. (ppm)	WL 517.0	Comments
1	Std1	Standard	0.500	0.272	
2	Std2	Standard	1.000	0.221	
3	Std3	Standard	1.500	0.185	
4	Std4	Standard	2.000	0.133	
5	Std5	Standard	2.500	0.092	

Standard Curve:

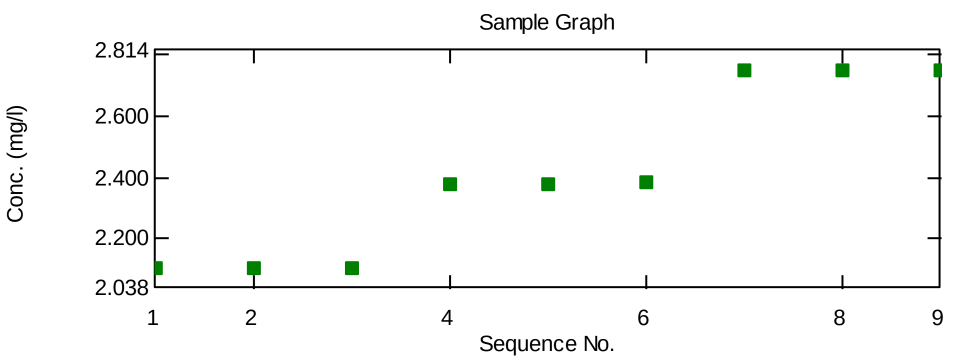


y = - 0.0894539 x + 0.314536
r2 = 0.99735

Sample Table:

Sample ID	Type	Conc (mg/100g)	WL517.0	Comments
S-A.1	Unknown	2.747	0.069	
S-A.2	Unknown	2.749	0.069	
S-A.3	Unknown	2.747	0.069	
S-B.1	Unknown	2.377	0.102	
S-B.2	Unknown	2.378	0.102	
S-B.3	Unknown	2.382	0.101	
S-C.1	Unknown	2.103	0.126	
S-C.2	Unknown	2.104	0.126	
S-C.3	Unknown	2.103	0.126	

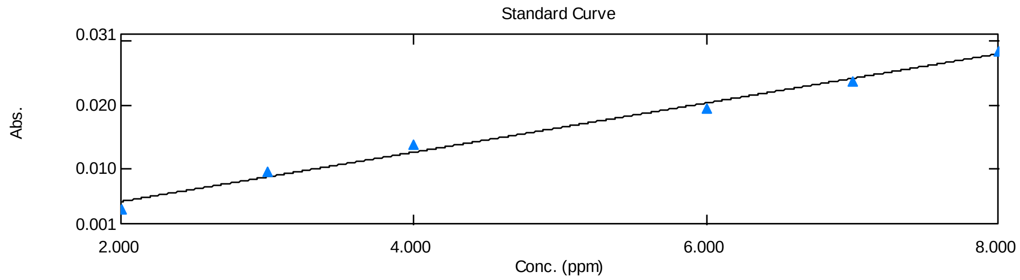
Sample graph:



TFC Standard Table:

Sample ID	Type	Conc (ppm)	WL415.0	Wgt. Factor	comments
Std1	Standard	2.000	0.004	1.000	Dilution factor 1
Std2	Standard	3.000	0.010	1.000	Dilution factor 1
Std3	Standard	4.000	0.014	1.000	Dilution factor 1
Std4	Standard	6.000	0.020	1.000	Dilution factor 1
Std5	Standard	7.000	0.024	1.000	Dilution factor 1
Std6	Standard	8.000	0.029	1.000	Dilution factor 1

Standard curve:

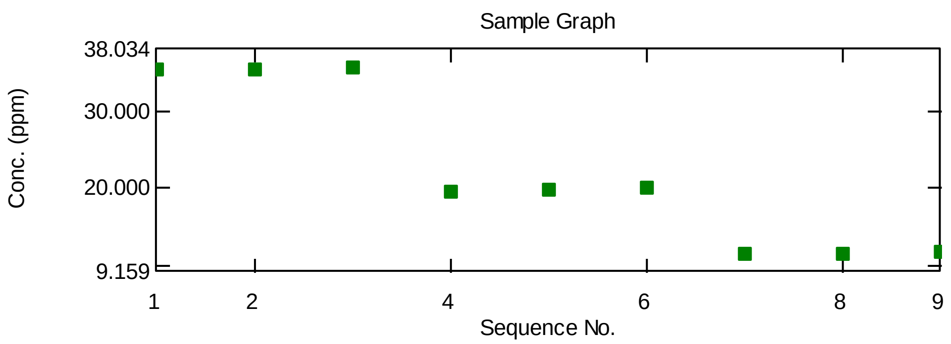


y = 0.00385110 x - 0.00271158
r2 = 0.98868

Sample Table:

Sample ID	Type	Conc (mg/100g)	WL415.0	Comments
S-A.1	Unknown	35.404	0.134	
S-A.2	Unknown	35.306	0.133	
S-A.3	Unknown	35.628	0.134	
S-B.1	Unknown	19.511	0.072	
S-B.2	Unknown	19.801	0.074	
S-B.3	Unknown	20.035	0.074	
S-C.1	Unknown	11.566	0.042	
S-C.2	Unknown	11.620	0.042	
S-C.3	Unknown	11.659	0.042	

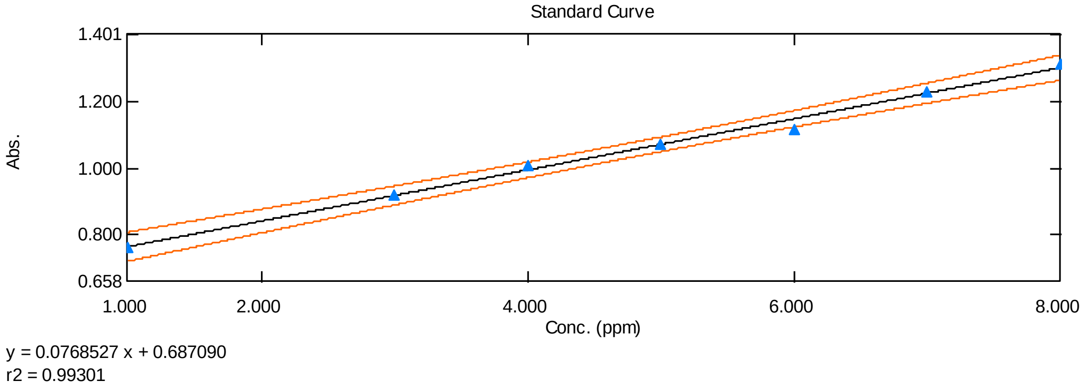
Sample graph:



TPC Standard table:

Sample ID	Type	Conc (ppm)	WL760.0	Wgt. Factor	comments
Std1	Standard	1.000	0.763	1.000	
Std2	Standard	2.000	0.780	1.000	
Std3	Standard	3.000	0.920	1.000	
Std4	Standard	4.000	1.007	1.000	
Std5	Standard	5.000	1.074	1.000	
Std6	Standard	6.000	1.115	1.000	
Std7	Standard	7.000	1.230	1.000	
Std8	Standard	8.000	1.314	1.000	

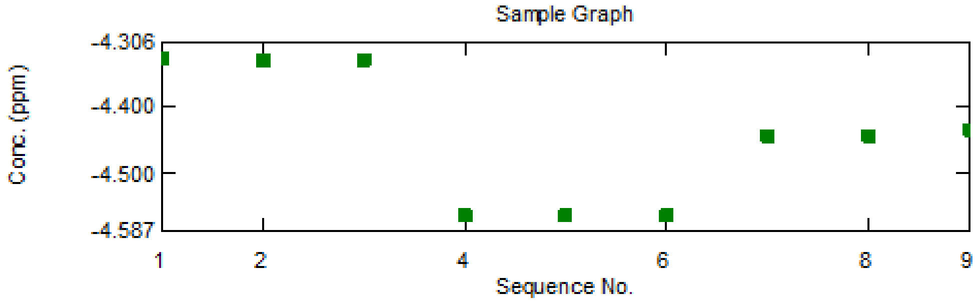
Standard curve:



Sample Table:

Sample ID	Type	Conc (mg/100g)	WL760.0	Comments
S-A.1	Unknown	4.329	0.354	
S-A.2	Unknown	4.332	0.354	
S-A.3	Unknown	4.333	0.354	
S-B.1	Unknown	4.562	0.336	
S-B.2	Unknown	4.564	0.336	
S-B.3	Unknown	4.563	0.336	
S-C.1	Unknown	4.445	0.345	
S-C.2	Unknown	4.446	0.345	
S-C.3	Unknown	4.437	0.346	

Sample graph:



TAC Sample Table:

Sample ID	Type	Conc (mg/100g)	WL520.0	Comments
S-A.1	Unknown	149.253	0.267	
S-A.2	Unknown	149.812	0.268	
S-A.3	Unknown	149.253	0.267	
S-B.1	Unknown	153.725	0.275	
S-B.2	Unknown	153.166	0.274	
S-B.3	Unknown	153.166	0.274	
S-C.1	Unknown	151.489	0.271	
S-C.2	Unknown	151.489	0.271	
S-C.3	Unknown	151.489	0.271	

Appendix C: Hedonic Rating Test (Mixed Fruits drinks powder)

Name of Tester………………………. Date…………………

Please taste these samples and check how much you like or dislike each one on four sensory attributes such as Color, Flavor, Texture, Taste and Overall Acceptability Use the appropriate scale to show your attitude by checking at the point that best describes you're 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 me.

HEDONIC	**CLOUR**				**FLAVOUR**				**TEXTURE**				**TASTE**				**OVERALL ACCEPTABILITY**			
	Formula				**Formula**				**Formula**				**Formula**				**Formula**			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Like extremely																				
Like very much																				
Like moderately																				
Like Slightly																				
Neither like nor dislike																				
Dislike slightly																				
Dislike moderately																				
Dislike very much																				
Dislike extremely																				

Extra comments on each sample if any:

N.B. Overall scale used: 9= like extremely; 8=like very much, 7= like moderately; 6= like slightly; 5= neither like nor dislike; 4= dislike slightly; 3= dislike moderately;2= dislike very much; 1= dislike extremely

…………………………

Signature of Judge

Brief Biography

Sidur Rahman passed the Secondary School Certificate Examination in 2011 and then Higher Secondary Certificate Examination in 2013. He obtained his B.Sc. (Hon's) in Food Science and Technology from the Faculty of Food Science and Technology of Chattogram Veterinary and Animal Sciences University, Chattogram, Bangladesh. Now, he is a candidate for the degree of Master of Science in Applied Human Nutrition and Dietetics under the Department of Applied Food Science and Nutrition, Faculty of Food Science and Technology, Chattogram Veterinary and Animal Sciences University (CVASU). His research interests are processing, preservation and development of modified food products, functional food product development and nutritional value analysis, quality control and quality assurance regarding food, chemical and microbial analysis of food, new techniques to measure food quality, taste and flavor, control of unit operation in food processing and instrumental food analysis with UV/Vis spectroscopy, Atomic Absorption Spectroscopy (AAS), High Performance Liquid Chromatography (HPLC), Gas Chromatography (GC), Gas chromatography–mass spectrometry (GC-MS), Liquid chromatography–mass spectrometry (LC-MS) etc. He also has an immense interest to work in improving the health status of people through paper guidance, suggestions and to create awareness among people about food safety and nutrition.