PROXIMATE ANALYSIS OF CARROT FORTIFIED BREAD AND ITS ORGANOLEPTIC STUDY

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Roll No: 0119/06

Registration No: 656

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A thesis submitted in the partial fulfillment of the requirements for the degree of Master of Science in Food Chemistry and Quality Assurance

Department of Applied Chemistry and Chemical Technology

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

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Dedicated

To my

Beloved

Friends, Family and

Honorable Teachers

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LIST OF ABBREVIATIONS

Abbreviation	Meaning
%	Percent
µg	Microgram
µl	Microliter
Ml	Milliliter
Gm	Gram
Mm	Millimeter
CVASU	Chattogram Veterinary and Animal Sciences University
FAO	Food and Agriculture Organization
Hrs	Hours
WHO	World Health Organization
fig.	Figure

ABSTRACT

The carrot is one of the most essential root vegetables, full of dietary fiber and bioactive substances like carotenoids, as well as considerable amounts of other functional elements with key health-promoting effects. When carrot powder is combined with refined flour, more vitamins, particularly vitamin A (beta-carotene), fiber, and minerals are added to the bread. The goal of combining carrot powder with refined flour is to create low-cost, widely accessible foods that are consumed by a large number of people and have numerous health advantages. In the current study, a methodical approach was used to create and standardize the procedure for making bread fortified with carrots using the cabinet drying method in various percentages. The proximate analysis, beta carotene value and sensory evaluation of the bread sample were determined. With the addition of carrot powder, the crude fiber, moisture, and fat contents of the bread gradually increased; 10 percent carrot fortified bread had the highest values at 2.3 percent, 28.20 percent, and 10.30 percent, respectively, and control bread had the lowest values at 0.30 percent, 27.60 percent, and 8.90 percent. Carrot powder substitution reduced the amount of carbohydrates. Bread with 10% carrots added has the lowest value (46.5%) of carbohydrates, while control bread has the greatest value (49.1%). The sensory analysis of the bread reveals considerable variations across the samples in terms of crust, shape, internal texture, appearance, and general approval. The bread samples' flavors and aromas differed noticeably from the control loaf. The beta carotene content is lower in 5% fortified bread than 10% fortified bread. The concentration of beta carotene is 3.002 mg in 5% fortified bread and 3.179 mg per 100 grams of 10% fortified bread respectively.

Keyword: Carrot, Bread, proximate composition, beta-carotene.

CHAPTER 1: INTRODUCTION

The carrot, or *Daucus carota L.*, is one of the most affordable and nutrient-dense vegetables. Because of the abundance of vitamins, dietary fiber, and other minerals in it, as well as the high carotene content that has anti-oxidative and anti-cancer properties, it is growing in popularity. Our bodies transform -carotene into vitamin-A, which is essential for maintaining the health of our immune system and epithelial tissue. Carrots include carotenoid, which is a potent antioxidant that helps to counteract the impact of free radicals and has inhibitory mutagenesis action, reducing the risk of cancer as well (Ibidapo Olubunmi Phebean et al., 2017).

One of the widely consumed root vegetables that is a member of the Apiaceae family and is grown worldwide is the carrot. The most common part eaten from carrot is root, although the greens can also be eaten (Surbhi et al., 2018). Original carrots were yellow and purple. According to agricultural statistics yearbook 2017, national estimates of acreages and production of carrot 2016-17 to 2018-19 are given in below:

Table 1.1: National estimates of acreages and production of carrot 2016-17 to 2018-19

2016-17		2017-18		2018-19	
Area (acres)	Production (MT)	Area (acres)	Production (MT)	Area (acres)	Production (MT)
4533	16306	5084	18674	5085	19246

(Source: Agricultural statistics yearbook, 2017)

In the human diet, carrots do not contain many calories, but they do provide nutrients in the form of phytochemicals like carotenoids, anthocyanins, and other phenolic compounds (Shalini et al., 2016; Kumar and Kumar, 2011; Shyamala and Jamuna, 2010; and Abdel-Moemin, 2016). The number of nutrients in carrots varies depending on the species, the location, and the age (Hasler and Brown, 2009).

Carotene, along with other phytochemicals and vitamins, is abundant in carrots. The carrot can be consumed raw, cooked, or in drinks. If processed properly, this inexpensive crop could be turned into products with value-added (Kumar and Kumar, 2011). Since carrots are seasonal and semi-perishable, it is difficult to make them readily available all year long. An essential alternative to preserving carrots for the rest of the year is to dry them during the primary season (Krishan et al., 2012). Additionally, these vegetables are affordable and widely accessible (Shyamala and Jamuna, 2010).

It was considered that processed products with the ideal phytochemical content should be developed without sacrificing taste or overall quality in order to benefit from the antioxidant capabilities and dietary fibre present in considerable amounts in carrot pomace. In light of this, tests were conducted to ascertain the acceptability of dehydrated carrot pomace for the creation of value-added goods as well as to investigate the impact of storage on their quality and shelf-life. Therefore, it was envisioned that the successful creation of these products might be in line with the present consumer trend. At the same time, it will offer consumers useful goods all year long, promote effective carrot pomace usage, and lessen the environmental pollution brought on by such items.

Bread is a staple food around the world and found in many sizes, shapes, types, and textures. Bread is a dynamic system food because of physical, chemical and microbiological changes which limit its shelf life. The loss of freshness which can be seen in the progressive firming-up of the crumb and unexpected taste and texture of the bread. These changes can be determined by physical and chemical changes (Valentina and Francesca, 2018). Several attempts have been made use the carrot in food products, i.e., breads, cakes, dressing salads, and producing functional drinks. The most frequently consumed bakery goods worldwide are loaves of bread (Shyamala and Jamuna, 2015). Dietary fiber (DF) can be added to bread in a variety of ways, for as by adding carrot powder (Zlatica et al., 2012). By using carrot powder into bread goods, DF intake is increased but calorie intake is decreased. This also makes bakery products fresh due to their ability to retain water (Kohajdova et al., 2011). There has been much attention from consumers to eat functional foods (Ndife and Abbo, 2009). Functional foods are foods have additional functions by adding new ingredients. Functional foods may be designed to have physiological benefits and/or reduce the risk of chronic disease beyond basic nutritional functions, and may be similar in appearance to conventional food and consumed as part of a regular diet (USDA, 2010).

By preventing changes in the product related to the environment throughout storage, the shelf life or storage stability of baked goods is described as maintaining the sensory and physical attributes associated with its freshness, such as crumb tenderness, pressure, and wetness (Baixauli et al., 2008). The sensory tests are an effective method for determining how long most perishable and semi-perishable foods will stay fresh. The effectiveness of sensory tests depends in the fact that sensory characteristics, where taste, smell, and appearance are the most prominent criteria, capture changes that occur in the product during storage. These modifications may result in product degradation and a corresponding drop in consumer acceptance (Witting et al., 2005). Some food products, according to Hough et al. (2003), do not have a set shelf life; instead, their shelf life will depend on how well the food product interacts with the user. The purpose of this study was to use acceptance tests to assess the nutritional value and shelf life of bread enriched with carrot powder during storage at ambient temperature (30°C) and refrigeration temperature (3°C).

Objectives of the Study:

- To Create a convenient product like carrot powder.
- To Determine a suitable procedure for dehydrating and grinding ingredients from raw materials to final goods.
- To Develop a new bread rich in beta carotene and other beneficial vitamin and minerals of carrot powder.
- To Compare the newly developed bread with regular bread.
- To Evaluate the beta carotene content after bake.

CHAPTER 2: REVIEW OF LITERATURE

One of the significant root vegetables used in the making of numerous nutrient-dense foods is the carrot. It is a good source of dietary fiber and beneficial bioactive substances like carotenoids. Carrots are regarded as a functional food with strong health-promoting benefits since they contain significant levels of a range of different chemicals. The beta-carotene concentration of carrots is likely their best-known attribute. (Actually, the vitamin beta-carotene bears the carrot's name!) Carrots can be an excellent source of this phytonutrient, but they also contain a fascinating array of other phytonutrients, such as polyacetylenes, anthocyanins (in the case of purple and red carrots), hydroxycinnamic acids, and other carotenoids, particularly lutein and alpha-carotene (especially falcarinol and falcarindiol). A great source of vitamin A is carrots (in the form of carotenoids). Additionally, they are an excellent source of biotin, vitamin K, dietary fiber, potassium, molybdenum, and vitamins B6 and C. Manganese, vitamin B3, vitamin B1, panthothenic acid, phosphorus, folate, copper, vitamin E, and vitamin B2 are all present in them in good amounts. The production and preservation of value-added goods made from powdered carrots were the focus of the current inquiry. Since carrot is used commercially to manufacture a variety of products, an effort was made to use it to take advantage of its nutritional components. In Bangladesh, there hasn't been much work done on drying and using dried carrot pomace for the creation of convenience items, and the literature that has been published on various uses of carrot, both domestically and internationally, has been analyzed under several headings.

2.1. Carrot production

One of the nutrient-dense vegetables that is grown all over the world is the carrot. Carrot commercialization is successful in the majority of areas. Only in Asia was over 60% of the world's carrot supply produced. One of the most widely consumed root vegetables and a major source of dietary carotenoids in Western nations, particularly the United States of America, is the carrot (*Daucus carota L.*) (Block, 1994; Torronen et al., 1996). China is the world's top producer of carrots (FAQ, 2008). There are reportedly 22,538 hectares of land planted with carrots in India, with an annual production of 4.14 lakh tons (Thamburaj and Singh, 2005). States that produce a significant amount of carrots in India include Uttar Pradesh, Assam, Kamataka, Andhra Pradesh, Punjab, and Haryana.

2.2. Chemical Composition

a) Moisture: Fresh carrots have a moisture level that ranges from 86.0 to 92.4 percent (Gill and Kataria, 1974; Gopalan et al., 1991; Howard et al., 1962).

b) Total soluble solids (TSS): Gill and Kataria (1974) studied biochemical composition of Asiatic and European cultivars of carrot (*Daucus carota L.*) and found that their TSS varies from 12.0 to 16.1 and 14.3 to 15.6°Brix, respectively. Sharma (1990) has reported total soluble solids in black and red carrot as 10.7°Brix and 9.06°Brix, respectively. The total soluble solids in 30 varieties of carrot studied by Anand (2001) have been found to varying from 6.57 to 8.69°Brix. In Asiatic carrot, a total souble solid of 8°Brix has been reported by Sharma (2004).

c) Titrable Acidity: While Wilson (1987) found that carrots only contain 0.02 percent citric acid, Luh and Woodroof (1982) claimed that whole carrots have a titratable acidity of 0.15 percent. The titratable acidity of black and red carrots, according to Sharma (1990), is 0.042 and 0.085 percent, respectively. Sharma (2004) also noted that the carrot had 0.10 percent lactic acid. The physicochemical components of the fresh carrot types "Pusa Kesar," "Pusa Meghali," "Sel-14," and "Sel-16" were examined by Sagar et al. in 2004. They found that the titratable acidity was 0.10, 0.10, 0.08, and 0.09 percent, respectively.

d) Sugars: Carrots' edible section contains 10% carbs on average. Four carrot cultivars have soluble carbohydrates in the range of 6.6 to 7.7 g/100 g. (Howard et al, 1962). Six varieties of carrot were found to contain 1.67-3.35 percent reducing sugars, 1.02-1.18 percent non-reducing sugar, and 2.71-4.53 percent total sugars, according to Kaur et al. (1976). According to Simon and Lindsay (1983), the proportion of reducing sugars in four hybrid carrot varieties varied from 6 to 32 percent of the free sugars. The free sugars found include fructose, sucrose, glucose, and xylose (Kalra et al, 1987). Reducing sugars (2.76 percent) and total sugars (6.36 percent) in Asiatic carrots have been reported by Sharma (2004).

e) Ascorbic Acid: Ascorbic acid is generally not regarded as being well-sourced in carrots. Wilson (1987) found a 6 mg/100 g ascorbic acid content in carrots, whereas Gopalan et al. (1991) observed a range of 3 to 7 mg/100 g ascorbic acid in whole carrots (1991). According to Salunkhe et al. (1991), there are 9 mg of ascorbic acid per 100 g of carrot roots. The initial ascorbic acid content in freshly harvested carrots during the seasons of 1994 and 1995 was observed by Howard et al. (1999) to be 4.3 and 3.9 mg/100 g, respectively. According to Srilakshmi (1999), fresh carrots contain 3 mg of ascorbic acid per 100 g. According to Sharma (2004), Asiatic carrot contains 4.41 mg of ascorbic acid per 100 grams.

f) Carotenoids: Carotenoids are abundant in carrot roots. In addition to serving as natural colors, carotenoids play an important role in food since they are increasingly thought to be responsible for a variety of biological processes in the human body. Important micronutrients for human health include carotenoids (Castermiller and West, 1998). Due to the discovery that -carotene, a component of carrots and a precursor to vitamin A, possesses antioxidant and anticancer properties, consumption of carrots and products related to them has gradually increased in recent years (Dreosti, 1993; Speizer et al., 1999). Carrot roots' edible section contains 6000 to 54,800 pg of carotenes overall per 100 g. (Simon and Wolff, 1987). Carrot roots also contain significant levels of thiamin, riboflavin, niacin, folic acid, and vitamin C in addition to carotenoids (Howard et al., 1962; Bose and Som, 1986). Because of their potential to prevent some types of cancer, carotenoids like -carotene have drawn a lot of interest in recent years (Bast et al., 1996; Santo et al, 1996; Van Poppel, 1996). For most people living in developing nations, where vitamin A insufficiency is still frequent, carotenoids are their main supply of vitamin A (Boileau et al., 1999); (Chakravarty, 2000). According to Panalaks and Murray (1970) and Simpson (1983), a and -carotene have 50% and 100% of provitamin A activity, respectively. Two molecules of retinol could be produced from one B-carotene molecule. Carotenoids have been associated with improved immune function and a lower risk of degenerative illnesses such cancer, cardiovascular disease, age-related muscle degeneration, and cataract development (Mathews-Roth, 1985; Bendich and Olson, 1989; Bendich, 1990; Krinsky, 1990; Byers and Perry, 1992; Krinsky, 1994; Bendich, 1994). Researchers have discovered that carotenoids may act as an Alzheimer's disease inhibitor (Zaman et al., 1992).

g) Phenolics: The phenylpropanoid metabolism produces phenolics, which are common plant constituents that are predominantly generated from phenylalanine (Dixon and Paiva, 1995). Carrots have phenolics throughout the entire root, although the periderm tissue contains the highest concentration (Mercier et al, 1994). The two main phenolic classes found in carrots are para-hydroxybenzoic acids and hydroxycinnamic acids (Babic et al., 1993). The total phenolic concentration of fresh and frozen carrot juice was found by Ninfali and Bacchiocca (2003) to be 0.26 mg/g and 0.20 mg/g, respectively. The extracted wet pulp from fresh and frozen carrots had phenolic contents of 0.14 mg/g and 0.10 mg/g, respectively.

h) Dietary Fiber: Carrot roots' crude fiber is made up of cellulose, hemicellulose, and lignin to varying degrees (71.7, 13.0, and 15.2 percent, respectively) (Kochar and Sharma, 1992). Carrots are rich in dietary fiber in addition to being strong in carotenoids. Carrot pulp comprises between 37 to 48 percent of the total dietary fibers, according to Bao and Chang (1994b). Dietary fiber is crucial for maintaining good health in humans (Anderson et al , 1994). Diets high in dietary fiber are linked to the prevention, mitigation, and treatment of various illnesses, including diverticular and coronary heart disorders (Anderson et al., 1994; Gorinstein et al., 2001; Villanueva-Suarez et al., 2003). The functional and technological qualities of dietary fibers make them desirable in addition to their nutritional benefits, and as a result, they can be used as food additives (Thebaudin et al., 1997; Schieber et al., 2001). When consumed in sufficient quantities, fruits and vegetables' fibers have a greater impact on blood lipids and carbohydrate metabolism (Berger and Venhaus, 1992; Truswell and Beynen, 1992). According to research done by Kumari and Grewal (2007) on the chemical makeup of carrot pomace powder, it has a total dietary fiber content of 55.81.67 percent. Tanska et al. (2007) estimated that the dried carrot pomace's total fiber content was 37.52.50 percent. Crude fiber in raw carrot, pomace and dried pomace has been reported to be 1.87, 15.89 and 18.35% respectively by Upadhyay et al. (2008).

2.3. Effect of Pre-treatments on Quality Attributes of Processed Products

In order to enhance quality, storage stability, and process effectiveness, pre-treatments are frequently used in the majority of drying processes. Although they result in losses, popular pretreatments including peeling, blanching, and sulphuring/sulphiting are necessary stages before dehydration. Blanching aids in the inactivation of enzymes, whereas sulfuring/sulphiting aids in the prevention of oxidative reactions such as browning, both enzymatic and non-enzymatic, and improves the retention of carotenoids and ascorbic acid during storage.

2.3.1. Blanching

Blanching is the technique of pre-heating a product by submerging it in steam or water for a short period of time. Wide temperature variations during water blanching are conceivable and may result in the loss of soluble nutrients. During water blanching, water-soluble vitamins may be lost as a result of leaching, heat degradation, or enzymatic oxidation. For the dried product to be of the highest quality, blanching time and temperature are crucial considerations (Jackson et al., 1996). The flavor and sensory qualities of dried fruits and vegetables are connected with the length of the blanching process (Shamaila et ai, 1996). Because there are fewer leaching losses of soluble nutrients, Magnon and Culpepper (1924) and Melinick et al. (1944) concluded that steam blanching is better to water blanching. Blanching is done to limit the activity of enzymes, but too little or too much blanching can result in a loss of free amino acids and sugars as well as poor quality and texture (Kaushal and Joshi, 1995). Researchers have looked at how pre-treatment conditions affect the physico-chemical characteristics of carrot juice as well as how different blanching solutions and blanching times (1–5 minutes) affect the juice's quality (Bin-Lim and Kyung-Jwe,1996; Sharma et al., 2007).

Following steam blanching, numerous studies have noted a rise in total carotenoids (Howard et al., 1999; Sulaeman et al., 2001; Puuponen-Pimia et al., 2003). Additionally, it has been claimed that blanching causes carotenoids to isomerize (Desobry et al; 1998). Ambadan and Jain (1971) discovered that blanching carrot shreds in a 5 percent sugar solution before dehydrating them improved the product's organoleptic and keeping qualities as well as gave the product an appealing hue. According to reports, the emergence of bad odors in dehydrated carrot and sweet potato flakes is linked to the degradation of 13-carotene (Ayers et al., 1964; Walter et al., 1970). The primary enzymes involved in the breakdown of beta-carotene are lipoxygenases (Kalac and Kyzlink, 1980). Blanching can lower these enzymes' activity levels (Reeve, 1943). According to research on the effects of blanching and pre-drying treatments on the stability of carotenoids and anthocyanins in papaya and pineapple, both of these pigments decreased as blanching temperature and time increased. In contrast, pre-drying treatments with sodium meta-bisulphite prevented carotenoids from oxidizing, while orthophosphoric acid had no effect on their oxidation. In a system where glycerol and sugar hold more moisture, carotenoids are better protected (Sian and Ishak, 1991). According to Banga and Bawa (2002), ascorbic acid concentration of samples declined whereas B-carotene content of both blanched and unblanched samples increased with increase in drying air temperature. Blanching carrots before juicing improves the color quality of carrot juice products as well as the appearance of carrot pulp goods (Sims et al, 1993; Bao and Chang, 1994b).

Chandler and Schwartz (1998) noted that the amount of carotenoids changed during processing, with blanching and lye peeling followed by pureeing increasing the amount from 4 to 11.9 and 10.4%, respectively, while canning (19.7%), dehydrating (20.5%), and microwaving caused a decrease in the amount of carotenoids (22.7 percent). Sharma et al. (2000) investigated the impact of various blanching techniques (steam, water, and microwave) on the stability of total carotenoids and discovered that when expressed on a dry weight basis, total carotenoids appeared to increase (2–25%) while when expressed on a total insoluble solid basis, total carotenoids decreased (9.9–10.6%). According to Mayer and Spiess (2003), following blanching at a high temperature (90°C) and in an oxygen-free environment, Kintoki carrot products achieve high availability and stability of carotene. After drying, blanched carrots have higher beta carotene but lesser ascorbic acid than their unblanched counterparts, although blanching had no effect on non-enzymatic browning (Negi and Roy, 2001). The rate of carotenoids degradation was minimal in all batches of carrots and was within the 0.31-0.54 range of water activity. The rate of carotenoids breakdown dramatically increased below and above this level. Carotenoids are initially more abundant in dried carrots after blanching, however they are greatly depleted after storage (Lavelli et al, 2006). Baloch et al. (1977a) evaluated the effects of pre-treatments before drying, including blanching, sulphiting, freezing, starching, sucrose, and sodium chloride dipping on the 6-carotene content of carrots and concluded that the loss of soluble solids by leaching during blanching results in an increase in carotenoids content and helps to reduce non-enzymatic browning, but encourages the enzymes for carotenoids destruction. Androetti et al (1980) investigated the impact of various operating settings on the losses of total carotenoids and ascorbic acid during the dehydro-freezing of dried carrots . According to their research, steam blanching for three minutes is the best blanching technique, and vacuum drying or drying at 80 degrees Celsius is the optimum drying technique before freeze drying the material.

2.3.2. Sulphuring/Sulphiting

According to Joslyn and Braverman (1954), Sulphur dioxide pre-treatment of fruits and vegetables aids in color and flavor preservation during processing and storage. Sulphuring or sulphiting is known to decrease microbial decay, prevent enzyme catalase oxidative changes, and facilitate drying by plasmolyzing the cells (Tanga, 1974). Sulphites and SO2 react with polyphenols and stop the production of color in the sugar amino system, according to Burton et al. (1963). Ponting (1960) discovered that 10 ppm of SO2 totally inactivates an enzyme while 1 ppm causes a 20% drop in activity. Deshpande and Tamhane (1981) also found that 2000 ppm of SO_2 totally inactivated the enzyme. Foods that absorb sulfur dioxide remove air from plant tissue, weaken cell walls to facilitate drying, defroy enzymes that darken cut surfaces, exhibit fungicidal and insecticidal qualities, and increase the vibrant, eye-catching color of dried fruits (Stafford and Bolin, 1972).

Materials that will be dried can also be pre-treated by sulphiting and blanching simultaneously. Sulphiting causes cell rupture and collapse, which reduces the volume of the cells and increases the hardness of the dried samples (Molyes, 1981). Carotenoids are lost less when carrots, both blanched and unblanched, are dried with sulphur dioxide treatment (Baloch et al., 1987). When carrots were pre-treated with sodium meta-bisulphite before drying, carotenoids were retained twice as well as when no sodium meta-bisulphite was used, according to Mohamed and Hussein (1994). Zhao and Chang (1995) demonstrated that carrots with a sulphite concentration of 2.5 percent retained their carotenoids better. Meta-bisulphite, according to Arya et al. (1982), inhibits the production of browning chemicals during dehydration and subsequent storage. Another method of preventing carotenoids from oxidation is to encapsulate B-carotene with maltodextrin (Wagner and Warthesen, 1995; Desobry et al., 1997).

2.4. Suitability of Carrot and Its By-Product (Pomace) For the Preparation of Various Processed Products

Products made from carrots include canned goods, dehydrated goods, drinks, candies, preserves, intermediate moisture foods, and gazra (Kalra et al., 1987). Several employees have observed that heat treatment and the application of chemicals have improved the color and quality of canned carrots (Chiang et al., 1971; Jelen and Chan, 1981; Edwards and Lee, 1986; Bourne, 1987). There have been reports that items with thermal processing have more carotenoids (De SA and Rodriguez-Amaya, 2004; Edwards and Lee, 1986). According to Pruthi et al. (1980), employing acidified brine with potassium meta-bisulfite, carrots could be stored in good condition for 6 months at room temperature even in non-air tight containers. Covering small whole carrots or slices of carrots with sugar or heavy sugar syrup can be used to make carrot candy or preserve, increasing the total soluble solids content to 70-75°B. (Beerh, 1984). By processing carrots, foods with an intermediate moisture level (approximately 55% moisture) have been produced (Jayaraman and Dasgupta, 1978; Sethi and Anand, 1982). Carrot juice extraction, preservation, and canning have all been covered by Stephens et al. (1976), Grewal and Jain (1982), and Bawa and Saini (1983). Drinks made with carrots have been made by combining the juice with other fruit juices or skim milk (Saldana et al., 1976). According to reports, carrot juice contains significant amounts of A and B-carotene (Munsch and Simard, 1983; Heinonen, 1990; Chen et al., 1995; Chen et al., 1996). According to reports, carrot juice can be combined with other fruit juices (Stoll et al., 2001). In Germany, carrot juice and juice blends rank among the most popular non-alcoholic drinks. The pretreatment conditions, such as pH, temperature, and duration, affect the yield and quality of carrot juice extracted by pressing (Sharma et al., 2006). The quality features of beverages with added beta-carotene have been described by Chan et al. (1988).

Due to their therapeutic benefits in addition to their high nutritional value, the production and consumption of fermented foods is constantly increasing (Karagul et al., 2004). Live lactic acid bacteria found in yogurt have a number of health benefits, including protection against stomach upsets, improved lactose digestion for lactose malabsorbers, a lower risk of cancer, lower blood cholesterol, improved immune function, and assistance with protein, calcium, and iron absorption (Perdigeon et al, 1998). The yoghurt sector also uses carrot juice (Schieber et al, 2002; Simova et al, 2004). Yogurt and carrot juice together would result in a nutrient-dense dish (Ikken et al, 1998; Raum, 2003). By combining milk with carrot juice at 5, 10, 15, and 20% before fermentation, carrot yoghurt has been made (Salwa et al, 2004). Numerous sweet goods made from carrots have also been documented to be processed and preserved (Sampathu et al., 1981; Beerh et al., 1984; Kalra et al., 1987). One of northern India's most well-known sweet delicacies is carrot halwa. To make it, shredded carrots are cooked with sugar and lightly fried in hydrogenated oil with grated dehydrated milk, or khoa (Sampathu et al, 1981). Another confection made with sugar, skim milk powder, dehydrated carrot, and other ingredients is a kheer mix (Manjunatha et al., 2003). It has been claimed that dehydrated carrot goods like carrot chops, carrot shreds, and carrot powder are used to make a variety of cuisines such carrot curry, carrot halwa, and biscuits (Suman and Kumari, 2002).

2.5. Dehydration and Rehydration Ratio

Adequate rehydration is essential in order to have satisfactory rating quality. Suman and Kumari (2002) reported that the rehydration of carrot shreds was faster as compared to carrot chops. The shreds had a maximum rehydration ratio (10.1) in 6 h, while the rehydration ratio of chops was (8.1) in 8 h. The lower rehydration ratio of carrot chops was due to the polysaccharide (com starch) gel absorbed on the cell walls causing changes in the texture and rehydration. Banga and Bawa (2002) reported that the blanched samples of carrot rehydrated better as compared to unblanched ones, with a maximum rehydration ratio of 9.57 for the sample dehydrated at 60°C. It might be due to blanching's enhanced permeability.In case of unblanched samples maximum rehydration ratio of 7.52 was obtained for the sample dehydrated at 70°C. Blanched samples had a maximum dehydration ratio of 21.4% for samples dehydrated at 50°C, whereas unblanched samples had a maximum dehydration ratio of 16.9% for samples dehydrated at 70°C. Ponting et al. (1966) examined the rehydration of osmotically treated and dried apple fruit chips and found that, while the texture of the treated slices was superior to that of the control samples, the rehydration was marginally less than that of the untreated sample.

Sagar and Maini (1991) recorded highest reconstitution ratio in water blanched and potassium meta-bisulphite treated mango slices (1: 4.95) followed by water blanched (1: 4.86) and control (1: 3.53). Jayaraman et al. (1990) used salt and sugar pre-treatments to improve the rehydration properties of dehydrated cauliflower. Eshtiaghi et al. (1994) investigated the impact of pre-treatments such blanching, freezing, and high pressure freezing on the ability of green beans, carrots, and potatoes to reabsorb water, and they found that pre-treatments improve the ability to reabsorb water. In dehydrated potatoes dried at various temperatures, McMim and Magee (1997) found a direct association between the internal porosity of the structure and the coefficient of rehydration.

2.6. Equilibrium Relative Humidity (ERH)

Dehydrated food storage properties and packaging specifications are based on a product's ERH. One of the most crucial aspects of dehydrated foods is hygroscopicity, which is affected by the product's initial moisture content. According to Labuza et al. (1970), water significantly affects the rates of chemical deterioration in meals, particularly for lipid oxidation and non-oxidation as well as non-enzymatic browning. According to reports, raw mango powder should be stored at a relative humidity of between 40 and 43 percent (Dabhade and Khedkar, 1980). However, when the powders were stored at relative humidity levels above 90%, mold growth started to occur Alkesh (2001) investigated the sorption behavior of apple powder and dehydrated apple rings and discovered that the ideal ERH was 57 and 54 percent, respectively. The dried apple products have a propensity to collect moisture and rot at higher relative humidity levels, particularly over 54 to 57 percent. The un-osmosed dehydrated carrot shreds are more hydroscopic than the osmosed dehydrated sample and require a lower relative humidity for safe storage, according to Singh's (2001) studies on moisture sorption isotherms. Sharma et al. (2000) studied the osmotically dehydrated apple storage conditions and found that the critical point (CP) was at 79.60% relative humidity with 30.30% equilibrium moisture content (EMC), while the optimum equilibrium relative humidity (ERH) was at 52.00% at 18.56% equilibrium moisture content. According to Subramanian et al. (1976), adding cane sugar (sucrose) to fruit powders causes a decrease in hygroscopicity and an increase in water activity. Similar to this, Kumar et al. (1991) also observed that the quality and storage durability of dried products were improved by pulverizing juice powder with cane sugar.

2.7. Packaging

Packaging is crucial for extending the shelf life of processed goods. The choice of an appropriate container for a given meal depends on the relative humidity and temperature at the time of storage. While tin, glass, and aluminum foils are regarded as good packaging materials, polyethylene degrades the quality of dry goods when it is exposed to gases and moisture during storage (Mahadeviah, 1999). Mehta et al. (1974) reported the use of 200-gauge polyethylene bags for the storage of dried apricot with a very little change in quality up to one year. The effect of different packaging materials (polyethylene, paper bags, silver color polyethylene and black color polyethylene and amber color bottles) on the ascorbic acid content of dried apricot during storage period of one year has been reported by Wahid et al. (1989). They observed that the amber color bottles and black color polyethylene were at par in retaining the maximum ascorbic acid content of 4.8 mg/100 g after one year from an initial value of 12.6 mg/100 g. The storage of garlic powder over a period of 3 month in various packages showed significant changes in browning, carbohydrate, protein, flavor and vitamin C. However, the loss of nutrients was less in case of aluminum foil laminates and brown glass bottles because of their barrier properties (Ambrose and Sreenarayanan, 1998). Different packaging materials were studied for safe storage of dehydrated apple rings by Sharma et al. (2000) and they observed that quality significantly deteriorated in polyethylene and glass packages during storage up to 6 months at ambient temperature (13-36°C) however, a minimum change in chemical composition and sensory attributes was observed in vacuum sealed laminated pouches. Sagar and Khurdiya (1999) have also reported that aluminum laminated pouches are better for packaging and storage of dehydrated ripe mango slices up to 6 months with respects of color, flavor, texture and overall acceptability over to other packaging materials. However, Sagar et al. (1999) observed that nitrogen packed material with aluminum laminated polyethylene (260 gauge) were most suitable than low density polyethylene bags of 200 and 400 gauge as well as different mode of packs such as air pack and vacuum pack in terms of retaining good color of dehydrated mango slices. When guava powder was packaged in polyethylene pouches, Khurdiya and Roy (1974) observed that ascorbic acid and SO2 retention during storage was related to gauge thickness. However, it was shown that 200-gauge polyethylene combined with aluminum foil worked best for ascorbic acid retention (15%), SO2 retention (9.3%), and less moisture increase (3.1%) over the course of six months. During 6 months of storage at room temperature, Dabhade and Khedkar (1980) noticed a quicker rise in moisture uptake in dried mango powder packed in paper bags compared to polyethylene bags. As a result, it was determined that variations in moisture absorption were caused by variations in the speeds at which various packaging materials transmit water vapor.

2.8. Effects of Storage on Quality of Processed Products

According to a chemical analysis of the B-carotene content of dried carrots (chopped, shredded, and powdered), the powder kept the most B-carotene after storage for three months (Suman and Kumari, 2002). Carotenoids in carrots are largely stable when kept frozen for a long time (Howard et al., 1999; Kidmose and Martens, 1999; Puuponen-Pimia et al., 2003). According to reports, many processed veggies stored in refrigerators have higher quantities of carotenoids than fresh vegetables (Gross, 1991; Kidmose et al, 2004). Although modest processing does not reduce the carotenoid concentration of carrots during storage, microbial deterioration and enhanced metabolic activity do (Lavelli et al., 2006). After 4 months of storage, it was shown that the reducing sugars and acidity of carrot pickle dramatically increased, rising from 84.5 to 86.5 mg/g and 1.57 to 2.61 percent, respectively (Chawla et al, 2005). However, Chawla et al. (2005) showed that after 4 months of storage, B-carotene retention had increased to a level of 31.71 percent. They also noted that storage drastically decreased the ficarotene content of carrot pickles since it went from 3.69 mg/100 g in fresh pickles to 1.17 mg/100 g after 4 months of storage. Ascorbic acid concentration was likewise shown to have decreased by 31.25 percent, going from 5.76 mg/100 g to 3.96 mg/100 g after 4 months of storage.

Studies on the isomerization of dried carotenoids during storage of carrot waste showed that it happens easily at high storage temperatures (45°C) or prolonged light exposure

(Chen and Tang, 1998). According to storage duration and temperature, the pigments of spray-dried carrot pulp waste were found to be susceptible to deterioration (Singh et al. 2006). Ready-to-eat dried carrot shreds with a low temperature (7°C) preserve more total carotenoids and beta carotene (Sagar, 2009). Sudhakar and Maini (1994) looked into the stability of carotenoids during storage of mango pulp and discovered that a higher concentration of sulphur dioxide aids in improved retention of carotenoids. They also discovered that because glass containers are more permeable to oxygen than PVC and HDPE, packaging pulp in glass containers preserves more carotenes. Ascorbic acid does not significantly change after storage if the veggies are properly prepped and dried. Negi and Roy(2001) have noted a decrease in the amount of -carotene and ascorbic acid and an increase in the non-enzymatic browning parameters of dried carrots after storage. Vegetables that have been dehydrated lose their color as a result of highly unsaturated molecules being oxidized by oxygen while being stored. The formation of an unpleasant flavor in dried carrots is linked to the degradation of beta carotene (Ayres et al., 1964). When carotenes are exposed to light, they can oxidize (Saguy et al., 1985). When carrots are dried by air, B-carotene rapidly degrades (Park, 1987), although treatment with sodium meta-bisulphite improves retention (Mohamed and Hussein, 1994). Abdellhaq and Labuza (1987) recommend 0.5 water activity for stable and microbe-free storage of dried apricots. In comparison to samples stored at normal temperature (15–25°C), the osmotically dehydrated papaya with 0.59 water activity kept at 0°C was of highly acceptable quality (Ahmed and Choudhary, 1995). According to Sagar and Maini (1997), dried onion slices maintained at high temperature (37°C) for up to 6 months exhibit higher alterations in reducing and total sugars as well as non-enzymatic browning. Sagar and Roy (1997) report that potato powder stored in cool chambers (26-28.5°C) and cold storage (6-7°C) for up to 9 months retains color and flavor better and experiences less non-enzymatic browning. In untreated lemon powder, Kumar (2003) found that after 9 months of storage, the total phenol content decreased by around 23.68 percent, from an initial value of 35.85 mg per 100 g to 23.45 mg. Numerous researchers have claimed that the total phenols' role in browning events during storage is what caused this drop (Takizawa et al., 1985; Wang et al., 1985; Cilliers and Singleton, 1989). During its six months of room temperature storage, lemon powder's ash composition remained unchanged, according to Kumar (2003) and Sharma et al. (2002). When mango powder was stored, Dabhade and Khedkar (1980) found an inverse association between browning and a drop in SO_2 level.

CHAPTER 3: MATERIALS AND METHODS

3.1 Materials

In Chattogram City, Bangladesh, local markets provided fresh, ripe carrots of high quality, which were then washed, peeled, and chopped into little cubes before being blanched and dried. To inactivate the polyphenol oxidase enzyme, carrot cubes were blanched for five minutes in hot water. Small cubes were dipped into ice water after five minutes. Except where otherwise noted, all chemicals were purchased from the Applied Chemistry and Chemical Technology Laboratory at the Chattogram Veterinary and Animal Sciences University (CVASU).

3.2 Carrot Powder

Carrot powder was the result from fresh, ripe tomatoes which have been dried in Cabinet Drier (60°C) at Food Processing and Engineering Laboratory (CVASU) and formed to powder. It was packaged in a plastic air tight bottle. As carrot powder has moisture content at lower level, the stability of this powder will be very high about 4-6 months. No artificial color and preservatives were added, that’s why it is totally natural.

Carrot powder processing:

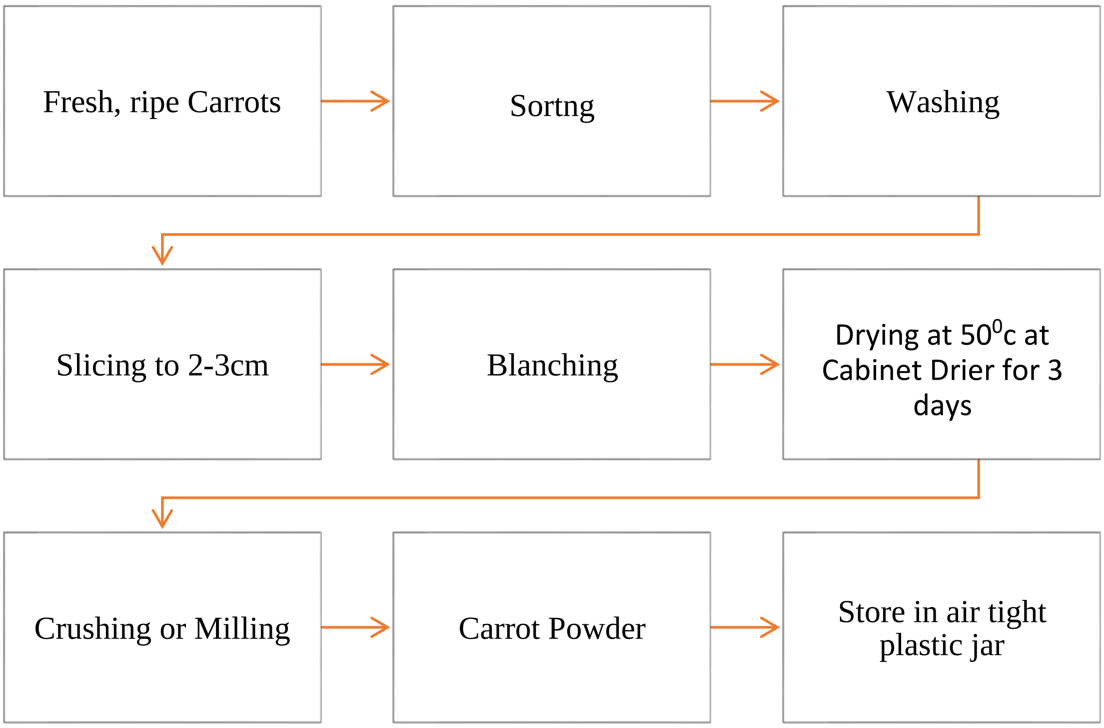

Figure 3.1: Carrot powder processing

3.3 Processing of Bread with Carrot Powder

- **Ingredients:**
  - Flour
  - Fresh carrot powder
  - Instant Yeast
  - Sunflower Oil
  - Milk Vita milk
  - ACI salt
  - Fresh Sugar
  - Drinking Water

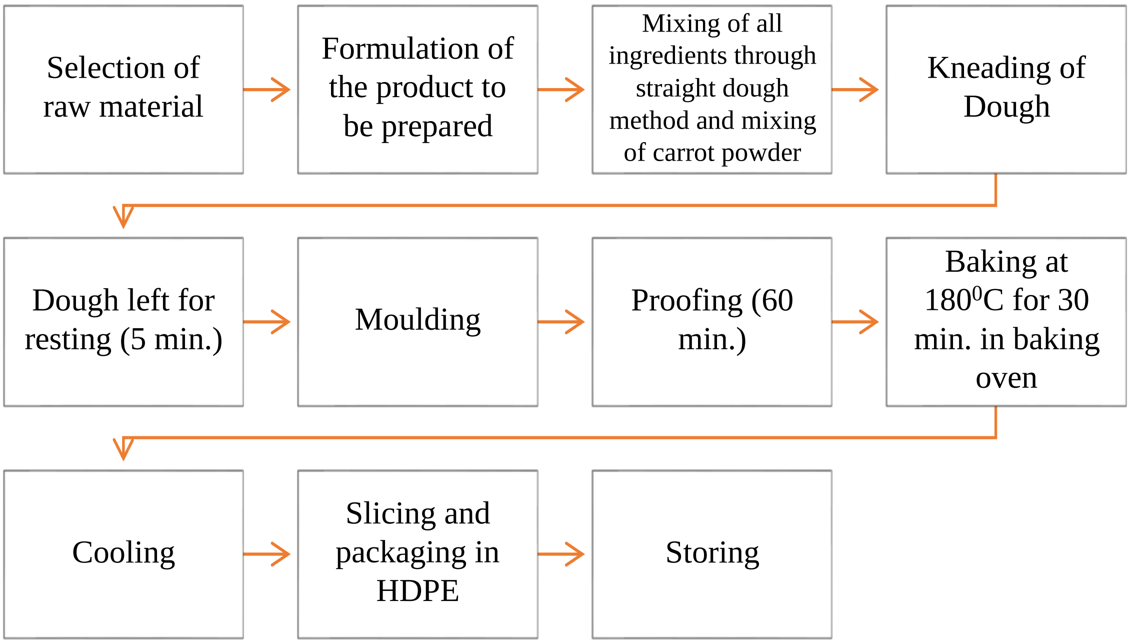

Figure 3.2 Manufacturing of carrot fortified bread

Table 3.1: Treatment Parameter for Bread

Treatment parameters			
Sr. No.	Treatments	Refined flour%	Carrot powder %
1.	WB	100	0
2.	T_1	95	5
3.	T_2	90	10

3.4 Proximate Analysis of Carrot Powder, Control Bread and Bread Fortified with Carrot with AOAC method

3.4.1 Determination of Crude Fiber

Principle:

The appropriately weighed sample is subjected to consecutive treatments with solutions of boiling sulfuric acid and sodium hydroxide. Filtration is used to remove the residue, which is subsequently washed, dried, weighed, and ashed. The term "crude fiber content" refers to the mass loss caused by ashing.

Reagent Required:

- H_2SO_4
- NaOH
- NaOH

Apparatus Required:

1. Conical flasks
2. Reflux condenser
3. Desiccator
4. Hot air oven
5. What-man filter paper
6. Volumetric flasks
7. Analytical Balance.

Procedure:

1. 0.5 grams of sample were collected in volumetric flasks.
2. After that, samples were boiled for 30 minutes in a reflux condenser with 50 ml of 0.225 N H2SO4.
3. Then, filters were used to capture the insoluble remains.
4. The acquired residual materials were then boiled for 30 minutes in a reflux condenser with 0.313M Na0H.
5. It was then chronologically rinsed and filtered to remove any residue that remained insoluble.
6. The resultant residue was then dried in an oven for two hours at 1032°C.

7. Weight measurements were obtained for dried residue on filter paper and blank filter paper.
8. The two filter papers were then ashed for 5 hours at 55025°C in a muffle furnace.
9. After ashing, the sample's mass of loss was noted.

Calculation:

Crude fiber content % = $(Weight\ of\ ash)/(Weight\ of\ sample\ taken)\ \times 100$

3.4.2 Determination of Moisture Percentage

Principle:

Foods' moisture content is a crucial consideration. Food products' increased moisture content, which results from absorbing moisture from the environment, promotes the growth of bacteria. Moisture is defined as the mass loss caused by the process of water vaporization when a sample is heated during thermogravimetric examination. A precision balance continuously calculates and logs the material difference. Before and after the drying process, the mass of the sample substance is measured to determine the final moisture content on a percentage basis.

Materials Required:

- Crucible
- Micro-Oven
- Spoons

Procedure:

a) Weight out previously dried crucible and about (5-10) g of sample was taken in it.
b) Then the sample in crucible was kept in a hot air oven.
c) After 4hrs the 1st reading was taken.
d) Then the process was repeated 3 times at 1hr interval.
e) Then the final reading was taken and moisture content determined.

Calculation:

Moister Content %

$$= (Weight\ of\ crucible\ with\ sample - weight\ of\ empty\ crucible)/(Weight\ of\ sample\ taken)\ \times 100$$

3.4.3 Determination of Ash Percentage

Principle:

Ash, a byproduct of heating in the presence of an oxidizing agent to remove water and organic debris, serves as a gauge for the overall quantity of minerals present in a food.

Materials:

- Crucible
- Micro-Oven
- Spoons.

Working Procedure:

1. Taken certain amount of sample in crucible.
2. Placed the crucible in oven at 105°C to remove moisture.
3. After removal of moisture placed the crucible with sample in muffle furnace at 550°C for 6hours.
4. Taken the weight of Ash

Calculation:

Ash Content % = $(Weight\ of\ crucible\ with\ ash - weight\ of\ empty\ crucible)/(Weight\ of\ sample\ taken)\ \times 100$

3.4.4 Determination of Fat Percentage

Principle:

One of the most used techniques for determining total fat is the Soxhlet device. This is due to the method's official recognition and relatively simple use. My processed food products may contain small amount of fat.

Materials and Reagents:

- Filter paper
- Rota vapor
- Reflux Condenser
- N- Hexane

Working Procedure:

i. Sample taken in filter paper

ii. Placed in soxhlet apparatus with n hexane in Round

iii. Bottom Flux for fat extraction

iv. Transferred it with n hexane in rota vapor for separation of fat.
v. The fat was then collected
vi. Heated into Final weight was taken.

Calculation:

$$\text{Fat \%} = (Weight\ of\ flask\ with\ fat - weight\ of\ empty\ flask) / (Weight\ of\ sample\ taken) \times 100$$

3.4.5 Determination of Protein Percentage

Principle:

Strong acids are used to breakdown food, which releases nitrogen that can be measured using an appropriate titration technique. The food's nitrogen content is then used to determine how much protein is there. Although certain modifications have been made to speed up the procedure and get more precise results, the core strategy is still utilized today.

Materials:

1. Beaker.
2. Glass crucible.
3. Nylon cloths.
4. Sintered Glass Crucible.
5. Desiccator.

Reagents:

- 0.3% NaOH
- 5% Acetic Acid
- 95% Alcohol
- Acetone.

Procedure:

1. A 250 ml beaker containing 5g of finely ground/pasted food sample was mixed with 150ml of a 0.3 percent NaOH solution to have a pH of roughly 11.6.
2. For two hours, the beaker's contents were heated at 50°C on a water bath while being occasionally stirred.
3. The solids were then filtered through a nylon cloth and centrifuged to remove them from the dispersion medium.
4. By gradually adding 5% acetic acid at the alkali extract's isoelectric point, proteins were precipitated.

5. The protein was then filtered through a sintered glass crucible, numerous times washed with 95 percent alcohol, and then washed with acetone after it had precipitated out.
6. At room temperature, the desiccator was used to dry the washed proteins.

Calculation:

Weight of Protein: Weight of dried filter paper with residue – weight of empty filter paper

$$\textbf{Protein \%} = (\textbf{Weight of Protein})/(\textbf{Weight of sample taken}) \times \mathbf{100}$$

3.4.6 Carbohydrate by Difference

The total amount of carbohydrates was estimated by taking 100 and deducting the amounts of moisture, ash, protein, and fat. Foods contain carbohydrates because they are a significant source of energy for bodily functions in humans.

Calculation:

Carbohydrate content % = 100 - (Moisture +ash + protein + fat)

3.5 Determination of Beta carotene

5 g of the sample were dissolved in acetone, mashed up until the entire color was removed, and then the extract was put into a separator funnel with petroleum ether in it. The colored component was divided up and gathered. Using a spectrophotometer, the absorbance was measured at a wavelength of 450 mm to quantify the amount of -carotene present in the petroleum ether extract. The following response variables were used to compute the carotenoid concentration expressed as -carotene (g/100 ml):

$$\beta\text{-carotene}=\frac{A\times V\times D}{E^{1\%}lcm}\ \text{(g/100ml)}$$

Where, $E^{1\%}1cm$ =coefficient of absorbency (2592 for petroleum ether),

A–Absorbency,

D-Dilution,

W-Weight of sample (g),

V-Volume (ml)

3.6 Sensory Evaluation:

15 untrained panelists from the fourth year and the first-year students of the faculty of Food Science and Technology, Chattagram Veterinary and Animal Sciences University, Khulsi, Chattagram, conducted sensory evaluation on freshly baked items (control and treatment). Crust, scent, internal texture, taste, appearance, and general appeal were the sensory evaluation criteria. The panelists evaluated each sensory quality of the bread samples using a nine-point hedonic scale (1 being neither like nor dislike, 2 being dislike very much, 3 being dislike moderately, 4 being dislike slightly, 5 being neither like nor dislike, 6 being like, 7 being moderately, 8 being like, and 9 being extremely) (Ranganna, 1991)**.**

3.7 Statistical Evaluation:

Data collected in this study was analyzed by one-way (Tukey's Multiple Comparison Test) using Microsoft excel 2007 and SPSS (Statistical Package for the Social Sciences) version 16.0. A significant difference was considered at the level of $p<0.05$.

CHAPTER 4: RESULTS

4.1 Gross Chemical Composition:

Figure 1 shows the chemical make-up of carrot powder (CP) and wheat flour (72 percent extraction). According to the findings, there were significant differences between carrot powder (CP) and wheat flour (72 percent extraction) in terms of crude protein, total carbs, fat, ash, and crude fiber.

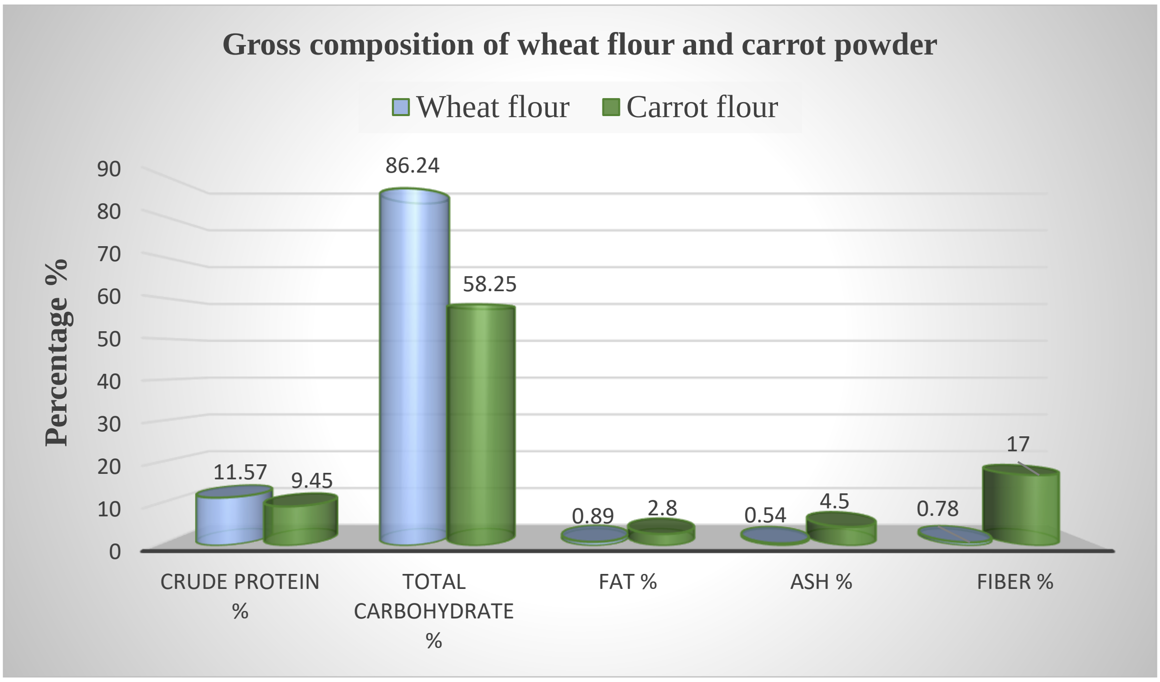

Figure 4.1: Gross chemical composition of wheat flour and dry carrot powder (On dry weight basis)

4.2. Proximate Compositions of whole wheat bread and carrot powder treated bread

To determine the overall mean difference of samples for close compositions, a one-way ANOVA (Analysis of variance) test (Table 2) was run. To determine which samples were the most significant for proximal components, Tukey's multiple comparison test was used. It was noted that all paired comparisons relating fat and carbohydrates were significantly different from one another. It was shown that carrot powder (CP) considerably differed in terms of moisture from bread treated with 5 percent carrot powder (T1), 10 percent carrot powder (T2), and whole wheat bread (WB). Between bread treated with 5% carrot powder (T1) and bread treated with 10% carrot powder (T2), between bread treated with 5% carrot powder (T1) and whole wheat bread (WB), and between bread treated with 10% carrot powder (T2) and whole wheat bread (WB), there was no discernible difference. Regarding ash, the results showed that every pairwise days combination was significant aside from bread treated with 5 percent and 10 percent carrot powder (T1), respectively (T2). Carrot powder (CP) was shown to be significantly different from bread treated with 5 percent carrot powder (T1), 10 percent carrot powder (T2), and whole wheat bread in terms of fiber and protein (WB). There was no discernible difference between bread treated with 5% carrot powder (T1) and bread treated with 10% carrot powder (T2), or between whole wheat bread (WB) and bread treated with 5% carrot powder (T1).

Table 4.1: Proximate composition (%) of Carrot powder (CP), bread treated with 5% carrot powder (T_1), bread treated with 10% carrot powder (T_2) and whole wheat bread (WB)

Proximate composition (%)						
Sample ID	**Moisture (Mean±SD)**	**Ash (Mean±SD)**	**Fat (Mean±SD)**	**Fibre (Mean±SD)**	**Protein (Mean±SD)**	**Carbohydrate (Mean±SD)**
CP	8 ± 1^{a}	4.5 ± 0.2^{a}	2.8 ± 0.1^{a}	17 ± 1^{a}	9.45 ± 0.02^{a}	58.25 ± 0.04^{a}
T_1	28.5 ± 0.01^{b}	1.4 ± 0.02^{b}	9.8 ± 0.1^{b}	1.6 ± 0.1^{bc}	11.4 ± 0.1^{bc}	47.3 ± 0.2^{b}
T_2	28.2 ± 0.03^{b}	1.6 ± 0.01^{b}	10.3 ± 0.2^{c}	2.3 ± 0.1^{b}	11.1 ± 0.01^{b}	46.5 ± 0.01^{c}
WB	27.6 ± 0.02^{b}	2.6 ± 0.01^{c}	8.9 ± 0.1^{d}	0.3 ± 0.2^{c}	11.5 ± 0.2^{c}	49.1 ± 0.02^{d}
F-test	1212**	593.842**	2078**	696.28**	217.574**	8369**

** Significant at P <0.01; Values followed by different superscript letters denote a significant difference; comparison done across the columns. Results are means ± standard deviation (SD) of triplicates (n=3).

4.3 Beta-carotene content (mg/100g) of Carrot powder (CP), bread treated with 5% carrot powder (T_1) and bread treated with 10% carrot powder (T_2)

The overall mean difference of beta-carotenes was determined using a one-way ANOVA (analysis of variance) test (Table 3). To confirm which beta-carotenes were most important for samples, Tukey's multiple comparison test was used. All paired comparisons were shown to significantly differ from one another in terms of beta-carotene.

Table 4.2: Beta-carotene content (mg/100g) of Carrot powder (CP), bread treated with 5% carrot powder (T1) and bread treated with 10% carrot powder (T2)

Beta carotene (mg/100g)	
Sample ID	**(Mean±SD)**
CP	24.653±0.003[a]
T1 (5%)	3.002±0.001[b]
T2 (10%)	3.179±0.005[c]
F-test	39850000000**

** Significant at P <.01; Values followed by different superscript letters denote a significant difference; comparison done across the columns.

Results are means ± standard deviation of triplicates (n=3)

4.4 Sensory evaluation

The breads (bread treated with 5 percent carrot powder (T1), bread treated with 10 percent carrot powder (T2), and whole wheat bread (WB)) were evaluated for their mean scores for crust, aroma, appearance, taste, internal texture, and overall acceptability, and the mean scores of their responses are shown in the table. It was noted that the samples' individual mean hedonic scores for aroma, look, and taste varied greatly. The mean score of crust, internal texture and general acceptance were not significantly different and the multiple Tukey's Multiple Comparison Test (TMCT) at (p<.05) was performed to show the pairwise significant difference of flavor, texture and taste of different categories. In terms of aroma, it was found that whole wheat bread (WB) and bread treated with 5% carrot powder (T1), as well as bread treated with 5% carrot powder (T1) and bread treated with 10% carrot powder (T2), did not significantly differ from one another, whereas whole wheat bread (WB) and bread treated with 5% carrot powder (T2) did. Whole wheat bread (WB), bread treated with 10% carrot powder (T2), bread treated with 5% carrot powder (T1), and bread treated with 5% carrot powder (T1) and 10% carrot powder (T2) were not significantly different in terms of appearance, but whole wheat bread (WB), bread treated with 5% carrot powder (T1), bread treated with 5% carrot powder (T1), and bread treated with 10% carrot powder (T2) were. Regarding taste for various types of bread, whole wheat bread (WB) considerably differs from bread treated with 5% and 10% carrot powder (T1 and T2, respectively), but there was no discernible difference between bread treated with 5% and 10% carrot powder (T1 and T2, respectively) (T2).

Table 4.3: Sensory Evaluation of Breads

SL. No.		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Mean Score±SD	F test
Crust	WB	9	9	9	8	8	7	9	9	8	8	7	8	8	8	8	8.2 ± 0.68	0.757^{NS}
	T_1	8	8	9	9	8	7	8	8	7	7	8	7	6	9	8	7.8 ±0.86	
	T_2	9	7	9	4	7	8	8	9	9	9	8	3	8	9	8	7.7 ±1.84	
Aroma	WB	9	9	8	9	8	7	8	8	8	8	8	9	6	8	8	8.7 ± 0.8^{a}	4.22*
	T_1	8	9	9	8	8	8	8	7	7	6	7	6	6	8	8	7.7 ± 0.9^{ab}	
	T_2	4	6	6	4	7	8	9	8	9	7	6	1	7	9	7	6.6 ± 2.2^{b}	
Appearance	WB	9	6	7	8	7	7	9	7	9	9	6	7	8	9	8	7.7 ± 1.1^{a}	10.07**
	T_1	7	9	9	9	8	7	8	7	7	6	8	8	8	7	7	7^{b}	
	T_2	8	8	9	8	8	8	9	8	9	7	8	8	8	8	8	8.1 ± 0.52^{a}	
Taste	WB	4	8	6	6	7	8	8	6	8	7	5	7	8	7	4	6.6 ± 1.4^{a}	15.20**
	T_1	8	9	9	9	9	8	8	8	7	8	7	8	7	9	8	8.1 ± 0.74^{b}	
	T_2	9	9	9	9	9	8	9	8	9	7	8	9	8	8	8	8.5 ± 0.64^{b}	
Internal Texture	WB	8	9	7	9	8	7	8	8	8	8	6	8	8	8	8	7.9±0.74	2.47^{NS}
	T_1	8	7	7	9	8	8	9	8	8	7	6	6	7	8	7	7.5±0.92	
	T_2	9	9	9	9	8	8	8	9	9	8	8	5	8	9	8	8.3±1.03	
General Appearance	WB	9	9	8	8	8	7	9	8	8	8	8	8	8	8	8	8.1±0.52	2.67^{NS}
	T_1	8	9	9	9	8	7	8	8	7	7	6	6	7	8	7	7.6±0.99	
	T_2	5	9	7	9	7	8	9	8	8	8	6	4	8	7	5	7.2±1.57	

NS=Not significant, * Significant at $P<0.05$, ** Significant at $P<0.01$;

Here, WB= 100% wheat flour, T1=bread treated with 5% carrot powder & T2=bread treated with 10% carrot powder.

CHAPTER 5: DISCUSSION

5.1 Gross Chemical Composition

Figure 1 shows the chemical make-up of carrot powder (CP) and wheat flour (72 percent extraction). Crude protein, total carbs, fat, ash, and crude fiber of 72 percentage wheat flour were found to be: 11.57, 86.24, 0.89, 0.54, and 0.78 percent, respectively, according to the results. These findings are comparable to those that Doweidar acquired (2002). The dry carrot's crude protein, total carbs, fat, ash, crude, and fiber contents were 9.2, 65.26, 2.9, 6.83, and 7.16 percent, respectively, according to the same data.

5.2 Proximate Compositions of whole wheat bread and carrot powder treated bread:

To determine the overall mean difference of samples for close compositions, a one-way ANOVA (Analysis of variance) test (Table 2) was run. To determine which samples were the most significant for proximal components, Tukey's multiple comparison test was used. It was noted that all paired comparisons relating the fat and carbs were significantly different from one another. It was shown that carrot powder (CP) considerably differed in terms of moisture from bread treated with 5 percent carrot powder (T1), 10 percent carrot powder (T2), and whole wheat bread (WB). There was no discernible difference between the 5 percent carrot powder-treated bread (T1) and the 10 percent carrot powder-treated bread (T2), or between the 5 percent carrot powder-treated bread (T1) and the whole wheat bread (WB), 10 percent carrot powder-treated bread (T2), and vice versa. Regarding ash, the results showed that every pairwise days combination was significant aside from bread treated with 5 percent and 10 percent carrot powder (T1), respectively (T2). Carrot powder (CP) was shown to be significantly different from bread treated with 5 percent carrot powder (T1), 10 percent carrot powder (T2), and whole wheat bread in terms of fiber and protein (WB). There was no discernible difference between bread treated with 5% carrot powder (T1) and bread treated with 10% carrot powder (T2), or between whole wheat bread (WB) and bread treated with 5% carrot powder (T1).From table 4.1 moisture contents for CP, T1, T2 and WB were 8.0±1.0%, 28.5±0.01%, 28.2±0.03%, 27.6±0.02%; ash contents for CP, T1, T2 and WB were 4.5±0.2%, 1.4±0.02%, 1.6±0.01%, 2.6±0.01%; fat contents for CP, T1, T2 and WB were 2.8±0.1%, 9.8±0.1%, 10.3±0.2%, 8.9±0.1%; fiber contents for CP, T1, T2 and WB were 17±1%, 1.6±0.1%, 2.3±0.1%, 0.3±0.2%; protein contents for CP, T1, T2 and WB were 9.5±0.02%, 11.4±0.1%, 11.1±0.01%, 11.5±0.2%; carbohydrate contents for CP, T1, T2 and WB were 58.3±0.04%, 47.3±0.2%, 46.5±0.01% and 49.1±0.02% respectively.

The moisture contents for bread without carrot powder, bread with 2.5% carrot powder, bread with 5% carrot powder, bread with 7% carrot powder, bread with 10% carrot powder were 38.81%, 37.36%, 37.01%, 33.43%, 32.06% respectively.

The ash contents for bread without carrot powder, bread with 2.5% carrot powder, bread with 5% carrot powder, bread with 7% carrot powder, bread with 10% carrot powder were 0.97%, 1.24%, 1.53%, 1.68%, 1.89% respectively.

The fat contents for bread without carrot powder, bread with 2.5% carrot powder, bread with 5% carrot powder, bread with 7% carrot powder, bread with 10% carrot powder were 2.06%, 1.97%, 1.94%, 1.90%, 1.86% respectively.

The crude fiber contents for bread without carrot powder, bread with 2.5% carrot powder, bread with 5% carrot powder, bread with 7% carrot powder, bread with 10% carrot powder were 0.47%, 0.94%, 1.48%, 1.87% 2.42% respectively.

The protein contents for bread without carrot powder, bread with 2.5% carrot powder, bread with 5% carrot powder, bread with 7% carrot powder, bread with 10% carrot powder were 9.98%, 9.2%, 8.89%, 8.38% and 8.16% observed initially by Pandey *et al*., 2016 during the evaluation of effect of storage period on the bread quality fortified with carrot powder maximum parameter of which are higher than the results presented in Table 4.1 which occurred may due to the type of heat treatment, preparation and formulation of dough etc.

According to Tiwari and Sarkar (2018), the fresh carrot had a moisture content of 87.02 percent, which dropped after drying to reach a consistent weight. The moisture content of dried carrot powder is 4.2 percent. Moisture levels in powder and flour greater than 14 percent will have an impact on storage quality since they may lead to the formation of mold, bacterial infestation, and agglomeration (Roongruangsri & Bronlund, 2016). Carrots had a fibre level of 8.2 g/100 g while they were fresh; this increased to 13.0 g/100 g after drying, which is attributable to concentration from moisture removal. Both Alam et al. (2013) and Adeleye et al. (2013) found comparable findings. On a dry basis, the amount of carbohydrates, ash, and energy ranged between 9.4 mg per 100 g, 7.0 mg per 100 g, and 57 kcal. Reduced carbohydrate (8.7g/100g), ash (6.1g/100g), and energy (49 kcal) were all discovered to be present in dried carrot powder. Gopalan et al. (1991) have reported the chemical constituents of carrot as moisture (86%), protein (0.9%), fat (0.2%), carbohydrate (10.6%), crude fiber (1.2%), total ash (1.1%), whereas, the values reported by Holland et al., (1991) for most of these parameters are different i.e., moisture (88.8%), protein (0.7%), fat (0.5%), carbohydrate (6%), total sugars (5.6%) and crude fiber (2.4%).

Kumari and Grewal (2007) have studied that carrot on dry weight basis contains $2.5 \pm 0.15\%$ moisture, $5.5 \pm 0.10\%$ ash, $1.3 \pm 0.01\%$ fat, $0.7 \pm 0.04\%$ protein $20.9 \pm 0.15\%$ crude fiber, $55.8 \pm 1.67\%$ total dietary fiber, $71.6 \pm 0.23\%$ total carbohydrate and 301 ± 0.09 kcal/100 g.

5.3 Beta-carotene content (mg/100g) of Carrot powder (CP), bread treated with 5% carrot powder (T1) and bread treated with 10% carrot powder (T2)

The overall mean difference of beta-carotenes was determined using a one-way ANOVA (analysis of variance) test (Table 3). To confirm which beta-carotenes were most important for samples, Tukey's multiple comparison test was used. All paired comparisons were shown to significantly differ from one another in terms of beta-carotene.

According to table 4.2 beta-carotene content of carrot powder (CP), bread treated with 5% carrot powder (T1) and bread treated with 10% carrot powder (T2) presented in Table 3 which were 24.653±0.003 mg/100g, 3.002±0.001 mg/100g and 3.179±0.005 mg/100g. These findings showed that the amount of beta-carotene increased as the amount of carrot powder in the bread increased. This qualifies them for usage as a component in the creation of functional foods or supplementary foods that are high in beta-carotene. They can also be the simplest way to treat a vitamin A deficit.

Tiwari and Sarkar (2018) found that dried carrot powder contains 31.72 mg of beta-carotene/100g sample which was higher than the result for carrot powder obtained from the Table 3. This variation may be due to the type of drying process, drying time, cultivar, climatic conditions etc.

5.4 Sensory evaluation

The breads (bread treated with 5 percent carrot powder (T1), bread treated with 10 percent carrot powder (T2), and whole wheat bread (WB)) were evaluated for their mean scores for crust, aroma, appearance, taste, internal texture, and overall acceptability, and the mean scores of their responses are shown in the table. It was noted that the samples' individual mean hedonic scores for aroma, look, and taste varied greatly. The mean score of crust, internal texture and general acceptance were not significantly different and the Tukey's Multiple Comparison Test at $p<0.05$ was performed to show the pairwise significant difference of flavor, texture and taste of different categories. It was observed that regarding to aroma, there were no significant difference between whole wheat bread (WB) and bread treated with 5% carrot powder (T1) as well as bread treated with 5% carrot powder (T1) and bread treated with 10% carrot powder (T2) but whole wheat bread (WB) and bread treated with 10% carrot powder (T2) were significantly different. Regarding appearance, whole wheat bread (WB) and bread treated with 10% carrot powder (T2) were not significantly different but whole wheat bread (WB) and bread treated with 5% carrot powder (T1) and bread treated with 5% carrot powder (T1) and bread treated with 10% carrot powder (T2) were significantly different. Regarding to taste for different category of breads, whole wheat bread (WB) is significantly different from bread treated with 5% carrot powder (T1) and bread treated with 10% carrot powder (T2) but there was no significant difference between bread treated with 5% carrot powder (T1) and bread treated with 10% carrot powder (T2).

Based on table 4.3 Sensory characteristics of the developed products (T1 and T2) and the commercial bread (WB) showed that the overall acceptability of the samples got the hedonic scale like very much. The results indicate that the formulated breads are equally acceptable since it got the same hedonic scale of that commercial sample WB (Table). However, no significant difference in terms of crust and crumb (internal texture) of the formulated products with the commercial products, which indicates positive sign for the developed product.

CHAPTER 6: CONCLUSION

Thus, it was determined that the use of carrot powder improved the quality of produced bread. Instead, it was discovered that the control sample lost quality faster than the experimental samples. After comparing the data, it is clear from the analysis that the carrot powder has a direct impact on the final product's quality. Because the protein content loss in the experimental samples is lower, the keeping quality of the samples is improved qualitatively. Definitely due to the varied amount of carrot powder, which ultimately raises the end product's mineral content while enhancing the baked bread's value. Additionally, the additional fiber slows down fat loss, demonstrating that fiber is effective at retaining fat. The current study also revealed that the varying amount of carrot powder in the experimental samples, which ultimately raised the mineral content of the finished product while adding value to the baked bread, was the primary cause of the higher fiber content in those samples. The Carrot powder is rich in Beta carotene having antioxidant activity. This is a beneficial fact of carrot powder to be used as a source for fortifying agents rich in both beta carotene and antioxidant. In such way, it can be added an economic value. Thus, this research work would help in creating a new field for fortification of food sector with reducing unemployment problem in Bangladesh.

CHAPTER 7: RECOMMENDATIONS AND FUTURE PERSPECTIVE

Recommendations for future research based on the findings of the development and evaluation of the bread fortified with carrot powder of the study include:

- Include the value analysis studies for developed carrot powder.
- Developing a product with value added ingredients, which may give some organoleptic changes.
- Formulation and evaluation of products based on HACCP procedures.
- Determining the shelf life period using food analysis and various types of packaging techniques.
- Developing the marketing plan for new product in to food service system.
- The beta carotene should be measured by different colorimetric method.
- The most important thing is that this study should be carried out in a room with controlled atmosphere in order to obtain more specific results.
- A microwave oven was used in this study. But it would have been better to use modern rotary gas oven to have better quality of bread.
- Improvement in mixing dough and maintaining humidity may develop the quality of bread. In current study bread quality was not so good due to hand mixing and humidity was not maintained properly during proofing time.

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