PREPARATION AND QUALITY EVALUTATION OF DATE POWDER SUBSITUTED MUFFIN

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A dissertation submitted to the Department of Food Technology, Central Campus of Technology, Dharan, Tribhuvan University in partial fulfillment of the requirements for the Degree of B. Tech. in Food Technology.

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Approval letter

This ***dissertation*** entitled ***Preparation and quality evaluation of date powder substituted muffin*** by **Samikshya Chhimal** has been accepted as partial fulfillment of the requirements for the **B. Tech. degree in Food Technology.**

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(Samikshya Chhimal)

Abstract

The goal of this study was to make a muffin by replacing sugar with date powder and evaluate its sensory and physiochemical qualities. Whole Wheat flour, sugar, fat, baking powder, and other supplies were gathered from Dharan's local market whereas dates were brought from Asan Bazar of Kathmandu. The dates were washed, pitted, dried and grinded in the powder form. The date powder was combined at the levels of 0, 12.5, 25, 37.5, 50 parts and was labeled A, B, C, D, and E, and was substituted in the recipe 3 parts baking powder, 55 parts sugar and date powder mixture, 55 parts fat, 57 parts egg and 10 parts water per 100 g whole wheat flour and superior product was determined by sensory evaluation.

The moisture content, protein, fat, crude fiber, ash and carbohydrate of whole wheat flour were found to be 11.22 %, 14.09 %, 1.2 %, 2.01 %, 2.02 %, 69.46 % respectively and were found to be 15.9 %, 2.4 %, 0.5 %, 5.5 %, 2.3 %, 72.9 % respectively and superior product obtained through sensory evaluation were determined. The statistical sensory analysis showed that 12.5 parts date powder substituted muffin was superior to all muffin formulation on the basis of taste, texture and overall acceptability. So, product B was selected as the best. Statistical analysis for the proximate composition of muffin showed that compared to control, date powder substituted muffin showed significantly higher ($p<0.05$) crude fiber, total ash, protein and fat whereas decreased carbohydrate content. Physical analysis of muffins showed significantly reduced loaf volume and specific loaf volume. Acid value and peroxide value was determined and after 7 days of storage. The acid value and peroxide value of the date powder substituted muffin (12.5:87.5 date powder and whole wheat flour) packed in LDPE were 0.62 mg KOH/g oil and 11.21 meq/kg oil respectively and was above the standard acceptable range which indicates rancidity and was not recommended for the human consumption.

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List of Abbreviations

Abbreviations	Full form
AACC	American Association of Cereal Chemists
AOAC	Association of Official Analytical Chemists
DFTQC	Department of Food Technology and Quality Control
WWF	Whole Wheat flour
RF	Refined flour
AE	Acrodermatitis enteropathica
AV	Acid value
PV	Peroxide value
ANOVA	Analysis of variance
LDPE	Linear density polyethylene
LSD	Least significant difference
MOAD	Ministry of Agricultural Development
USDA	United States Development of Agriculture:

List of plates

Part I

Introduction

1.1 General introduction

A Muffin is an individual-sized, baked product. Muffins are sweet baked goods that are popular among customers due to their soft texture and characteristic flavor.(Ramya and Anitha, 2020). Muffins are called quick breads because they contain no yeast, and therefore, they don’t require all of the time spent on kneading, rising and resting. English muffins originating in London were made from yeast dough, in contrast to the quick-bread muffins served in early America (Hui *et al.*, 2007). The key ingredients in muffins, flour, sugar, butter, and egg, play a significant role in the final product's structure, look, and eating quality.(Karaoglu and Kotancilar, 2009; Martínez-Cervera *et al.*, 2012) . A nice muffin has a uniform shape, a slightly curved top, good color, a delicate crust, and a flavorful crust. They should easily break without crumbling. (E. L. Miller, 1971).

One of the main ingredient in muffins is sugar. Sugar functionality is critical in baked goods, not just for contributing to the product's sweetness, but also for color, flavor, rheological, and textural properties. Due to increasing awareness of food product nutritional quality and its relationship to health, people are searching for alternatives. Obesity and overweight are becoming more common, with evidence suggesting that obesity has increased thrice in Europe during the 1980s.(Gao, 2018) . Muffins are created with refined flour and contain a significant level of sugar. Refined flour products are easy to digest since they include neither bran nor germ. They're also quickly digested and can trigger blood sugar and insulin levels to surge rapidly and it will result obesity and diabetes type-2 in consumers.. (Anonymous, 2020b).

Dates (*Phoenix dactylifera*) are the edible sweet fruits from date palm trees which are widely cultivated across Northern Africa, the Middle East and South Asia. Date pulps are high in easily digestible sugars (70%) such as glucose, fructose, and sucrose, along with dietary fibers and low in protein and fat. (Al-Farsi. M.A. and Lee, 2008)

Dates are high in fiber, vitamins, and minerals such as calcium, potassium, and selenium, making them extremely nutritious. Dates contain simple sugars that are easily digested by the body, and the anti-oxidants found in them help to slow down cell death. Dates aid in the

growth of the brain. Supplementing with date fruits may help reduce the risk of Alzheimer's disease, as well as delay or slow its development. (Selvaraju et al., 2015)

Although there are many different types of dates on the market, such as fresh dates, date paste, date powder and date syrup, free-flow date powder would be extremely useful in extending shelf life, ease of handling, and bendability with a variety of cuisines cooked at home and in industry.(Manickavasagan et al., 2015). In recent years the consumption of table dates is decreased and its utilization in food products has been increasing day by day like bars, paste, honey, jam, vinegar, cookies, wafers, squares and powder (Ahmad *et al.*, 2005)

1.2 Statement of problem

Muffins are a popular culinary item that customers equate with pure pleasure. While taste is still a big component in food product selection, individuals nowadays are also concerned about nutrition and health. (Lin, 2012). Sugar functionality is critical in baked goods, not just for contributing to the product's sweetness, but also for color, flavor, rheological, and textural properties.

Sugar has a bittersweet reputation when it comes to health. Consumption of too much sugar results increase in blood sugar level. One experiences mood changes, exhaustion, and headaches if your blood sugar is not stable. Additionally, it fuels cravings, which start the vicious cycle of fake hunger resulting obesity. While we all enjoy the occasional indulgence in sweet, meals that raise blood sugar quickly raise the risk of obesity, heart disease, and diabetes. (Bell and Sears, 2003). Recent studies also point to links between these high-glycemic diets and various cancer types.(Michaud *et al.*, 2002; Romieu *et al.*, 2004). As if being sick wasn’t bad enough, studies have shown that sugar can interfere with the way your body fights disease in other words it affects our immunity. (Nutter *et al.*, 1983). An increased risk of depression has been linked to eating a lot of processed meals, especially high-sugar items like cakes and sugary drinks.(Akbaraly *et al.*, 2009; Guo *et al.*, 2014) Researchers think that the negative effects of sugar on mental health may be caused by blood sugar fluctuations, neurotransmitter dysregulation, and inflammation (Kivimäki *et al.*, 2014).

Refined flour is the finest variety of wheat flour. The bleaching process gives it the white color and makes it appealing to the eyes. The high starch content of refined grain and lack of fiber due to the removal of the bran and germ produces a rapid increase in blood sugar when consumed. The raise of blood sugar and insulin, causing metabolic dysfunction.

Refined flour is depleted in nutrients and contains harmful additives. Refined flour displaces healthier foods from the diet. Refined flour is associated with cardiovascular disease, hypertension and other lifestyle diseases. (Kresser).

Given the call to action to promote sustainable health and nutrition, the field of public health practice has recently continued to broaden. So, for nutritional counseling professionals all over the world, eating habits and the nutritional content of consumed foods are becoming increasingly essential fields of research (Maduabum, 2015). A healthy lifestyle includes good eating, which is essential. People in developing nations appear to be switching from high-fiber, low-calorie, and low-protein diets to low-fiber, high-calorie, and high-protein diets in terms of their nutritional intake.(Maduabum, 2015; President's Council on Sports)

1.3 Objectives

1.3.1 General Objectives.

The main objective of this work is preparation and quality evaluation of the muffin using date powder as the sucrose substitute.

1.3.2 Specific Objectives

1. To perform physiochemical analysis of the whole wheat flour and date powder.
2. To prepare muffins using different proportion of date powder, substituting sugar.
3. To determine the acceptability of best formulation through sensory analysis.
4. To study physiochemical properties of the final product.
5. To perform cost evaluation.

1.4 Significance of work

In both developed and developing nations, obesity, overweight, type 2 diabetes, and the spread of cancer have rapidly increased, especially among vulnerable groups. The food industry is increasingly focusing on the production of reduced fat/sugar/energy foods with a sensory quality comparable to conventional products in order to promote a healthier diet. This is because consumers are becoming more aware of the nutritional quality of food products and the link between health and food we consumed. An example of popular

breakfast or snack food is muffin. Due to muffins' high sugar content, numerous efforts have been made to increase their nutritional value, such as replacing sucrose with high-intensity sweeteners or adding dietary fiber.

Consumer demand for better, or more specifically healthier, food options is rising. A good substitute for creating new items is reformulating existing ones. In actuality, the addition of functional ingredients has improved the original recipes and led to the creation of many healthier food components. On the other side, the reformulation has led to several alterations in the product's various characteristics, such as sensory and shelf life. In order to guarantee the success of the new product, reformulated or upgraded foods demand the examination of numerous factors. First, there is the cost of production, which should be reasonable and have little effect on the final cost of the new product. Furthermore, there should be no changes to safety, shelf life, or sensory qualities. Consumers should be satisfied with the product in sense of sensory values, nutritional value as well as price.

Dates have also been utilized as a sweetener in food in the form of syrups, spreads, sugar, and powder.(Manickavasagan *et al.*, 2013). Date flesh is low in fat and protein but concentrated in carbohydrates, particularly fructose and glucose. The glycemic index of date powder is found to be low to medium due to presence of fructose. Dates have iron in adequate amount which is beneficial for anemic patients. Dates are full of antioxidants, mainly carotenoids and phenolic compounds which prevent quick aging of skin. Insoluble dietary fiber made up the majority of the dietary fiber in dates (8.0 g/100 g). Dates include dietary fiber, which is advantageous to the digestive system's health. Dietary fiber is made up of non-hydrolyzed plant matter. (Al-Farsi. M.A. and Lee, 2008) Dates contain small amounts of oxytocin which work as a lactagogue when included in a woman's daily diet plan throughout her breastfeeding period. It promotes brain health too. (Selvaraju *et al.*, 2015) Furthermore, dates are thought to offer aphrodisiac, immune-boosting, strength-building, pain-relieving, and illness-prevention characteristics, including cancer and heart disease protection.(A. Ali *et al.*, 2012)

Due to this health benefits, date are being used as sweetener alternative in most of the products and in different forms. In the current state of malnutrition practices, where children are affected by the dominance of junk food, the production of nutritious muffins with date powder rather than sugar is an excellent alternative to other snacks. Date muffins would be

a terrific alternative snack for both adolescents and working people to meet their energy and nutritional demands. (Nadeem *et al.*, 2017)

In the rapidly changing socio-economic scenario, incorporation of functional ingredients like fibers, proteins, hydrocolloids, herbs and vegetable oils is necessary as it will help to attractive to consumers which automatically increase the yield of the muffins.

1.5 Limitations of work

1. Only one variety of dates will be used for powder making process.
2. Copper, manganese and phosphorous could not be studied due to lack of facility.
3. Instrumental textural analysis was not carried out.

Part II

Literature review

2.1 Muffin

Muffins are baked goods in individual sizes. Muffins are spongy-textured cereal-based baked goods with a porous structure and high volume. (Martínez-Cervera *et al.*, 2012). A Muffin is an individual-sized, baked product. Muffins are sweet baked goods that are popular among customers due to their soft texture and characteristic flavor.(Ramya and Anitha, 2020). They're similar to cupcakes, except they're normally less sweet and don't have any icing. There are also savory muffins like cornbread muffins and cheese muffins. Outside of the United Kingdom, the name refers to a disk-shaped muffin bread known as an English muffin. There are numerous types and varieties of muffin mace, including low-fat and flavors having a specific ingredient baked into the muffin, such as blueberries, chocolate chips, raspberry, cinnamon, pumpkin, date, nut, lemon, banana, orange, peach, strawberry, almond, and carrot. Muffins are commonly offered during breakfast, but they can also be served for tea or other meals. (Limbachiya and Amin, 2015).

The top of a muffin should be homogeneous, beautifully rounded top, devoid of peaks, without cracks, and large in relation to its weight. The surface should be pebbly or slightly rough and polished, and the exterior hue should be a consistent golden brown. With an even, round-holed grain, the inner texture should be moist, soft, and light. Inside, the color will be creamy white or slightly yellow, and streaks will be absent. Fruits, nuts, herbs, cheese, chopped meats, and spices can be added to the batter to make different muffins.(Anonymous, 2005). Customers expect a soft, spongy, and sensitive crumb with some resistance to disintegrating.(Öztürk and Mutlu, 2019)

2.1.1 The method of mixing

Muffin formulations are characterized by a complex mix of interacting ingredients, mostly sugar and varying degrees of fat, flour, eggs, and baking powder, which result in the porous structure and large volume characteristic of muffins..(Baixauli *et al.*, 2008) There are two primary methods for mixing muffins i.e. the muffin method and the conventional method. The muffin method involves combining two mixtures: a wet mixture (eggs, soft or liquid fat, milk, and sugar) and a dry mixture (flour, baking powder, and salt) (flour, leavening and

flavorings like cocoa powder). After they've been prepped and the oven has been warmed, they're combined and swirled briefly before being panned and baked. .(E. L. Miller, 1971)

2.1.2 Preparation of muffin

Dry and wet materials were separated first. Wheat flour, oat flour, baking powder, and sugar made up the dry components. Egg, water, and butter made up the wet ingredients. Before adding the milk and oil, the egg was beaten for two minutes. All of the dry ingredients were properly combined in a separate basin. After that, both the dry and wet ingredients were blended together to make a mixed muffin batter. (Rahman *et al.*, 2015) as shown in Fig 2.1.

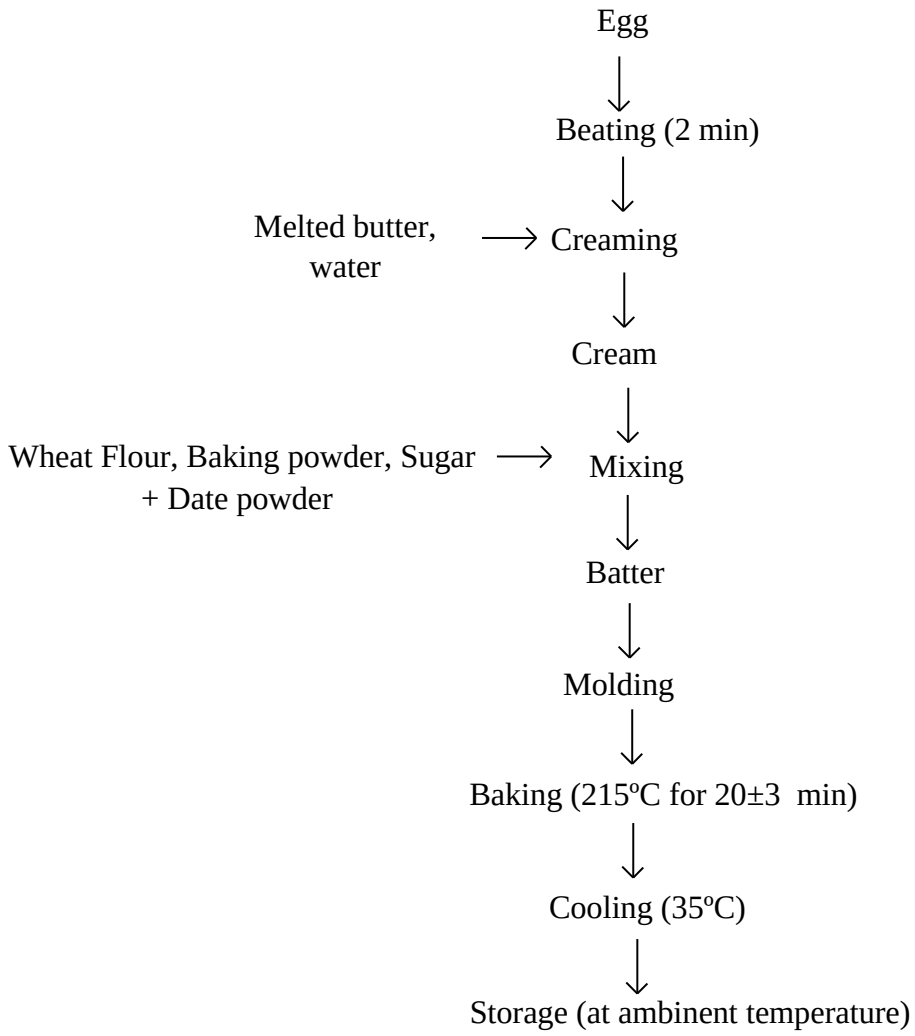

Fig. 2.1 Flow chart for the preparation of muffin

Source: Rahman *et al.* (2015)

2.1.3 Objective of mixing

The fundamental goal of mixing is to create a homogeneous mixture, which entails achieving a nearly uniform distribution of the ingredient. Batch and continuous processes can be distinguished. Overall, the component concentration should be evenly distributed in the output stream, not vary with time, and each section of the combination should be processed the same way. (Ashokan *et al.*, 2013)

2.1.4 Chemical composition of a muffin

Chemical composition of muffin is shown in Table 2.1

Table 2.1 Chemical Composition of muffin

Constituents	percentage
Moisture	20.33
Protein	14.37
Fat	17.60
Carbohydrate	44.28
Total dietary fiber	2.22
Ash	1.21

Source: Rahman *et al.* (2015)

2.2 Dates

Dates (*Phoenix dactylifera*) are the edible sweet fruits from date palm trees widely found in tropical and sub-tropical origin. Date trees typically reach about 21–23 meters (69–75 ft) in height growing singly or forming a clump with several stems from a single root system. The leaves are 4–6 meters (13–20 ft) long, with spines on the petiole, and pinnate, with about 150 leaflets. The leaflets are 30 cm (12 in) long and 2 cm (0.79 in) wide. (Anonymous)

Date are mostly cultivated across Northern Africa, the Middle East and South Asia. Over the centuries, the date palm has achieved great spiritual significance in three of the world's

major religions, Islam, Christianity and Judaism. Nepal is considered as number one importer of Dates in world market (Anonymous, 2021) About 31,707,007 kg dates were imported in Nepal from Algeria(9,840 kg), China(1,013 kg), India(3,581 kg), Pakistan(30,769,208 kg), Saudi Arabia(160,000 kg), Thailand(300 kg) and UAE(763,065 kg) in fiscal year 2076/77. Pakistan is the major exporter of dates in Nepal.(Anonymous, 2020a).

2.2.1 Composition of dates

Carbohydrates, dietary fiber, enzymes, protein, fat, minerals, vitamins, phenolic acids, and carotenoids are the main chemical components of date fruit. Date fruit chemical composition changes depending on ripening stage, cultivar, growing environment, post-harvest circumstances, and other factors. The chemical makeup of date fruit influences its nutritional and therapeutic properties.(Tang *et al.*, 2013)

Table 2.2 Chemical composition of dates:

Composition (g/100g)	Date (Fresh) (in g)	Date (dried) (in g)
Moisture	59.2	15.3
Protein	1.2	2.5
Carbohydrates	33.8	75.8
Fat	0.4	0.4
Fiber	3.7	3.9
Minerals	1.7	2.1

Source:Anonymous (2017)

2.2.2 Nutritive value of Dates

2.2.2.1 Dates Carbohydrates and sugars

The carbohydrates in dates, particularly sugars, are the most essential components, accounting for up to 78 % of the total. (Makki *et al.*, 1998) and provide a readily available source of energy to the human body The carbohydrate contents in fresh and dried dates ranged from 47.8 to 59.4 (mean 54.9) and 66.1 and 88.6 (mean 80.6) g/100 g, respectively. At the intermediate stages (Khalal and Rutab), large amount of sucrose was accumulated but no additional glucose or fructose were detected. Almost all of the sucrose is converted to glucose and fructose at the end of the maturation process (Tamar). The levels of glucose, fructose, and sucrose were 29.04 to 34.53 g/100 g, 20.72 to 23.65 g/100 g, and 1.86 to 2.34

g/100 g, respectively. (A. Ali *et al.*, 2012) Date flesh contains glucose and fructose, which are quickly absorbed during digestion and can cause a spike in blood sugar.(S. Liu *et al.*, 2000). The sweetness of foods is due to sugars. Fructose, which is twice as sweet as glucose and can cause satiety, accounts for about half of the sugars in dates.(A. Y. Ali *et al.*, 2009),

2.2.2.2 Dietary fibers

Dates are a good source of dietary fiber, ranging from 6.4 % to 11.5 % in 14 different types depending on the variety and stage of ripening. (Al-Shahib and Marshall, 2003). Some low-quality dates used for industrial applications have been discovered to contain up to 10% crude fiber. (Barreveld, 1993). Both soluble and insoluble fibers can be found in dates. Cellulose, hemicelluloses, pectin, lignin, and insoluble proteins constitute the primary fractions. Date flesh was found to contain 1.55 % cellulose, 1.28 % hemicellulose, and 2.01 % lignin (on a fresh weight basis) in one study. Insoluble fiber is the major component of dietary fiber in dates. (Barreveld, 1993).

As the cellulose activity in dates increases during ripening, the amount of cellulose, hemicellulose, and lignin in the fruit decreases. (El-Zoghbi, 1994). Dates can be employed in the manufacturing of fiber-based foods and dietary supplements, thus their dietary fiber content can add to their nutritious value. A daily consumption of 100 g of dates can provide 32 % of the necessary dietary fiber allowance. (Marlett *et al.*, 2002). Insoluble fiber with a higher amount produces satiety and has a laxative effect due to increased stool weight. Dietary fiber has been demonstrated to lower blood cholesterol levels and reduce the risk of a variety of disorders, including diabetes, hypertension, bowel and colon malignancies, cardiovascular disease, and diverticulosis. (Cummings *et al.*, 1992; Marlett *et al.*, 2002).

2.2.2.3 Date Proteins

Dates contain hint levels of protein. Protein content in date fruit ranges from 1% to 3%. The loss of moisture causes the increased protein and fat levels after drying. Due to changes in cultivation, drying conditions, and analytical methods employed for their detection, their concentrations vary amongst types. (A. Ali *et al.*, 2012) The average protein content of fresh and dried dates is 1.50 and 2.14 g/100 g, respectively. Decrease in amino acid content was reported as maturation progressed (Ishurd *et al.*, 2004). The amino acid concentration of the same stage of development might vary greatly. Proteins are also involved in non-oxidative browning and tannin precipitation during ripening. The protein level of the pulp was reported

to range from 1.7 to 2.95 % on a fresh weight basis, whereas the average protein content of date seeds was 5.22% (Barreveld, 1993; Makki *et al.*, 1998). Dates contain several important amino acids and their amino acid pattern is advantageous to human needs, despite the fact that their protein content is too low to be regarded a substantial nutritional source. (A. Ali *et al.*, 2012)

2.2.2.4 Dates Lipid

Dates contain a minor amount of lipids. Lipids are concentrated mostly in the skin and play a greater physiological role in the protection of the fruit than in the nutritional content of the date flesh. (Barreveld, 1993). Fresh dates have an average lipid content of 0.14 g/100 g, while dried dates have an average lipid content of 0.38 g/100 g. It was reported that date flesh had 0.2 %–0.5 % saponifiable oil, whereas date seed contained 7.7%–9.7% oil. On a fresh weight basis, date pulp can include lipids ranging from 0.31 % to 1.9 %.(Al-Hooti *et al.*, 1997)

2.2.2.5 Vitamins and mineral contents

Dates contain numerous vitamins and minerals, with mineral content ranging from 0.1 to 916 mg/100 g of dried date. (Al-Farsi *et al.*, 2005b; Barreveld, 1993; Khan *et al.*, 2008). Dates are high in selenium, copper, potassium, and magnesium, and include moderate amounts of manganese, iron, phosphorus, and calcium, as well as modest amounts of boron. (Barreveld, 1993). Date species have also been discovered to be a good source of selenium. (Al-Farsi *et al.*, 2005b). Dates are good for patients with hypertension since they are high in potassium and low in sodium. Boron is beneficial in the treatment of brain cancer. Rheumatism can also be treated with boron and vitamins. The date can be used as an iron supplement without the negative effects that iron tablet supplements often cause, such as nausea, headaches, and anorexia. (Al-Showiman, 1998)

Dates have been found to contain at least six vitamins at observable amounts (thiamin, riboflavin, niacin, ascorbic acid, pyridoxine, and vitamin A). (Al-Hooti *et al.*, 1995; Al-Shahib and Marshall, 2003). Dates might thus be regarded a reasonable source of vitamins when compared to other dried fruits. (USDA, 2011). Because vitamins are lost during the drying process, fresh dates have higher vitamin concentrations than dry dates. Riboflavin, pyridoxine, niacin, and folic acid are all found in moderate amounts in dried dates. Dried

dates include relatively low amounts of thiamin, ascorbic acid (vitamin C), and vitamin A.(A. Ali *et al.*, 2012)

2.2.2.6 Pigments and Anti-oxidants in Dates

Carotenoids (beta-carotene, lycopene, lutein, zeaxanthin, neoxanthin, etc.), phenolics (ferulic, sinnapic, syringic, vanillic, gallic, caffeic, protocatechuic, coumaric acids, and derivatives such as dactilyferic acids, etc.), flavonoid glycosides (luteolin,methyl luteolin, quercetin, and methylquercetin) flavones, flavonols (catechin, epicatechin), flavoxanthin, anthocyanins are present as phytochemicals in dates. The concentration of these phytochemicals, however, decreases with advancing stage of fruit maturity. (Al-Farsi *et al.*, 2005b; Biglari *et al.*, 2008; Shahidi and Naczk, 2004)

Carotenoids and phenolic compounds (flavonoids and anthocyanins) have antioxidant and antimutagenic properties in various degrees. Total phenolics make a bigger contribution to antioxidant activity in dates than ascorbic acid. (Shivashankara et al., 2004). The majority of the antioxidants found in dates are hydrophilic, or water soluble. (Al-Farsi et al., 2005b). Many researchers from different places like Algeria, Kuwait, Iran and others have suggested that dates are not only a rich source of natural antioxidants, but their high level of active phenolic acids can also help to improve the flavor and color of a product.(Al-Farsi *et al.*, 2005b; Biglari *et al.*, 2008; Vayalil, 2002).

2.2.2.7 Carotenoids in dates

When compared to other dried fruits, dates offer a moderate supply of carotenoids. (Boudries *et al.*, 2007; Hart and Scott, 1995). However, the amount of carotenoids in date fruit varies depending on the variety, maturity stage, drying, and post-harvesting conditions. Lutein, -carotene, zea-xanthin, and neoxanthin are the major carotenoids present in dates. Dates are likely to contribute to the human demand for vitamin A, despite the fact that not all carotenoids behave as provitamin A. Fresh and dried dates have been found to have 913 and 973 g/100 g of total carotenoids, respectively. (Al-Farsi *et al.*, 2005a). The concentration of carotenoids in freeze-dried dates has been observed to be 0.18 mg/100 g of fresh weight which is really less than others form. (Ben-Amotz and Fishler, 1998).

2.2.2 Medicinal value of Dates

2.2.2.1 Anti-oxidants, anti-inflammatory, antimutagenic, and anticancer activities

Dates are thought to have a variety of medicinal benefits, including providing strength, fitness, and relief from a variety of maladies and pains, such as fever, stomach disorders, memory disturbances, mental disorders, and as an aphrodisiac and immune booster. They are also thought to protect against a variety of chronic illnesses, including as cancer and heart disease. (Duke, 1982; Vyawahare *et al.*, 2009) as dates have shown to contain antioxidant and antimutagenic properties (Al-Farsi *et al.*, 2005a; Allaith, 2008; Vayalil, 2002). Date flesh and seed extracts, both methanolic and aqueous, have been proven to have anti-inflammatory activities, suppressing foot swelling and adjuvant arthritis. (Mohammed and Al-Okbi, 2004)

Because dates are high in hydroxyl pope folic acid, consuming them can boost your body's immunity and resilience to cancer. (Ishruda and John, 2005) observed that remedies prepared from the extracted polysaccharides (glucans) from Lybian dates suppressed the growth of Sarcoma 180 tumor cells in female CD1 mice in a dose-dependent manner. In the Middle East, it is widely believed that eating dates, especially first thing in the morning on an empty stomach, can reverse the effects of any harmful material to which the subject has been exposed. (Vyawahare *et al.*, 2009).

A variety of herbal formulations are on the market that have been demonstrated to decrease or prevent alcohol-induced hangover symptoms in human volunteers, as well as to protect acute and chronic alcoholics against liver problems. (Thornfeldt *et al.*, 2006). It's also thought that eating seven dates a day may protect kids from anxiety and nervous illnesses.(A. Ali *et al.*, 2012)

2.2.2.2 Treatment of abdominal troubles

Dates are commonly used to address stomach problems. Dates are utilized as a detersive (cleaning agent) and astringent in the treatment of digestive problems due to their high phenolic content. In rats, water extracts of date meat have been demonstrated to accelerate the gastro-intestinal transit time of meals in a dose-dependent manner. A daily dose of seven dates soaked in water and given before bedtime is said to kill Ascaris (giant intestinal roundworms) because of its anti-dysentery and laxative effects.(Al-Qarawi *et al.*, 2003).

Dehydration caused by vomiting and diarrhea can be treated with a decoction of dates that are free of fibrous material and a pinch of table salt. Date water extracts are also thought to aid in the reduction of stomach hyperacidity and blood acidity. Because date fibers are soft and do not irritate a sensitive intestine or stomach, water extracts of dates are occasionally added to milk to aid in the digestion of milk for children with sensitive stomachs. Crushed dates in milk are incredibly nourishing and restorative, especially during recovery.(A. Ali *et al.*, 2012)

2.2.2.3 Antianalgesic, antipyretic, and protection against colds, sore throat, and fever

Infusions, decoctions, syrups, and pastes made from dates are used to cure sore throats, colds, and bronchial catarrh (inflammation of mucus membranes). Although there is no clinical evidence to support such claims, dates have antioxidant and anti-inflammatory effects. (Allaith, 2008; Mohammed and Al-Okbi, 2004; Vyawahare *et al.*, 2009) could be regarded as the primary cause of such consequences Date pastes with margarine are considered analgesic and antipyretic, and are consequently applied externally to abscesses as well as toxic bites to prevent poisoning. Zinc is thought to be an active component that inhibits allergic reactions. Skin allergies and Acrodermatitis Enteropathica (AE) are treated using soaps made from powdered date seeds. AE is a rare inherited autosomal metabolic recessive disorder caused by a lack of zinc absorption or uptake that can be treated with oral zinc supplementation (Park *et al.*, 2010) Dates in daily meals can have a sedative effect on allergy sufferers. (A. Ali *et al.*, 2012)

2.2.2.4 Effects on pregnancy, lactation

The most prevalent therapeutic use of dates and their compounds is as a tonic, particularly for women nearing delivery or in the postpartum period. Women can use dates as a tonic to strengthen their uterine muscles before and after giving birth. Due to the presence of various constricting compounds, dates not only aid to activate the delivery process, but they may also help to prevent post-birth hemorrhage. Dates' potassium, glycine, and threonine concentrations are thought to stimulate milk hormone synthesis (prolactin). Because dates contain small amounts of oxytocin, they can work as a lactagogue when included in a woman's daily diet plan throughout her breastfeeding period.(A. Ali *et al.*, 2012)

2.2.2.5. Other medicinal benefits of date fruits

Dates are consumed regularly with meals and their decoction is used as an eye-lotion to aid in eye cleanliness and as a treatment for night blindness and ophthalmic problems. Due to their high potassium and low sodium content, dates can assist to reduce potassium insufficiency, maintain the salt-potassium balance in the body, and may aid in the treatment of heart disorders, particularly after diarrhea, vomiting, or the use of diuretic drugs. The glycemic index of dates has been shown to be low to medium. (A. Y. Ali *et al.*, 2009) and as a result, it may have a positive impact on diabetes patients' glycemic and lipid control. (C. J. Miller *et al.*, 2003).

2.3 Dates powder

The date powder was prepared following procedure given by (Sablani *et al.*, 2008) with some modification. Pitted and washed dates were used. Before steaming, pitted dates were chopped into little pieces and placed in baking trays. These trays were placed in the oven and dried for 24 hours at a low temperature of 65 °C. The dates were pulverized in a electric grinder after drying. During the grinding process, 50 % maltodextrin was added to achieve a fine and free-flowing powder. Date powder was ground and packaged in an airtight container. The use of high-molecular-weight carrier agents or drying aids (maltodextrin and gum Arabic) can help to minimize stickiness and raise the powder's glass transition temperature.(Sablani *et al.*, 2008).

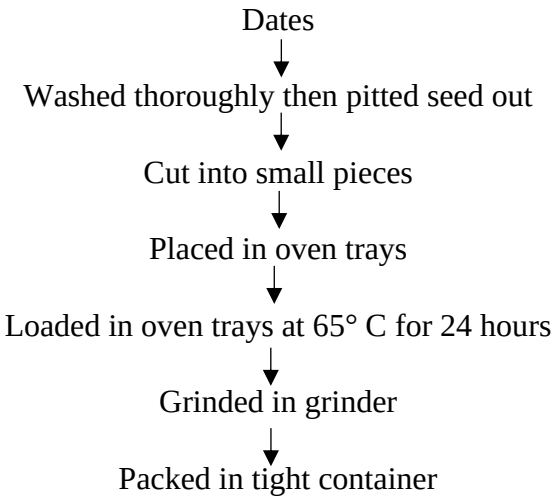

Fig 2.2 Preparation of date powder

Source: Sablani *et al.* (2008)

2.4 Wheat

Wheat is a member of the Gramineae family, or "grass" family, and belongs to the genus *Triticum*. The two primary wheat families currently planted for food usage are common wheat (*Triticum aestivum*) and durum wheat (*Triticum durum*). Common wheat is classed as hard or soft, red or white, spring or winter for commercial purposes. In the baked items that consist of so many bakery products, hard and soft wheat flour are employed. Hard wheat flour is used largely for yeast leavened items such as cakes, English muffins, Danish sweet rolls, cinnamon rolls, and cake-type doughnuts since it has a high protein level(Matz, 1989). Soft wheat flour is best for producing biscuits, pastries, cakes, and morning cereals because it has a low protein concentration.(Hoseney, 1989).

Wheat flour required for muffin making is obtained from the endosperm in the form of particle size that must pass through a flour sieve usually 100 mesh per linear inch (J. Kent and Amos, 1983). Wheat flour is unique among grain flours in the sense that when blended with the proper amount of water, it produces an elastic mass. The presence of insoluble proteins, collectively known as gluten, is responsible for this particular feature. Gluten-forming proteins (glutenin and gliadin) account for roughly 75-80% of total flour proteins. (Mukhopadhyay, 1990). The flour required for cake, muffin should have 7.5% gluten in it for tender, crumbly texture. (Lauterbach and Albrecht, 1994).

The strong flour protein has long links with few bonds while weak flour protein has short links with many bonds. During cake making weak and easy to stretch, soft wheat flour is found to be better (Kim and Kim, 1999).Beside the natural quality of flour, the modifications in the flour strength can be done by various treatments. Treatment of the flour with sulphur dioxide reduces the flour strength. Heat treated flour added to untreated flour is claimed to strengthen the flour. According to Kent and Amos, improvers have some effect upon the nature and character of the gluten and cause it to behave, during fermentation, like the gluten of the stronger flour. (J. Kent and Amos, 1983)

2.4.1 Structure of wheat

From a botanical point of view, the wheat grain is a single-seeded fruit called a caryopsis but it commonly goes by the denomination of kernel. It consists of a pericarp (or fruit coat), which surrounds the seed and adheres tightly to a seed coat. This seed is composed of an

embryo or germ and an endosperm enclosed by anucellar epidermis and a seed coat. The caryopsis develops within modified leaves called glumes. They are readily removed during threshing and the grain is said to be naked since it has an uncovered caryopsis. The color can vary from light buff or yellow to red-brown. It is due to the absence or presence of red pigmentation in the seed coat and is genetically controlled. (N. L. Kent, 1983)

Structurally it can be divided into three main parts; the bran coating, the germ or embryo and the endosperm. The bran coating constitutes approximately 13% of wheat and consists of six principle layers. The outer three layers together form the pericarp; this consist of the epidermis 0.5%, epicarp 1% and the endocarp 1.5%. The inner layer form the seed coat of which the testa, 2% of the grain, contains the coloring matter by which wheat can be classified as red, white or yellow. Next to the testa comes the nucelar layer 1% and finally aleurone cells which constitute 7% of the grain. The germ is approximately 2% of the grain and is that wheat plant in embryo. It has three main parts, the plumule which becomes the green shoot, the radical or radix, which becomes the rootlet and scutellum which contains by far the greater % of the vitamin content of wheat grain. The germ also contains the large proportion of diastatic enzymes which convert starch into sugar (N. L. Kent, 1983).

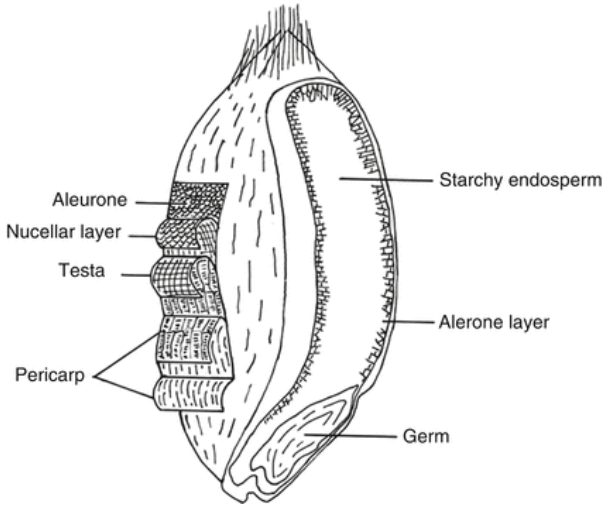

Fig 2.3 General structure of wheat

Source:S. Cauvain (2015)

2.4.2 Chemical composition and nutritive value of wheat

Wheat is most generally believed of as a source of protein, calories, vitamins, and minerals, as stated in Table 2.3. In terms of nutrient content, it is comparable to other cereals. It has a

higher protein content than rice, maize, and sorghum, and is about on par with other cereals. The amount of protein in a plant is affected by its variety, as well as environmental and cultural factors such as temperature, growing methods, soil type, and nitrogen availability (Khan, 1984). There is no doubt that the number of individuals who eat wheat for a significant portion of their diet is in the billions. As a result, the nutritious value of wheat proteins should not be underestimated, especially in developing nations where cake and other goods make up a large part of the diet. Wheat provides nearly 55% of carbohydrate and 20% of the food calories (Kumar and Jhariya, 2013).

The nutritive value of wheat flour is the same as that of wheat flours of lower extraction rate viz. white flour and whole flour as milled, differ from wheat I nutritive value because of removal of varying amounts of bran, germ and other endosperm in which the concentration of protein, mineral and vitamins is higher than in inner endosperm (Kent-Jones and Amos, 1967).

Table 2.3 Chemical composition of wheat flour (whole and refined)

Parameters	WF	WWF
Moisture (g)	13.3	12.2
Protein (g)	11	12.1
Fat (g)	0.9	1.7
Carbohydrate (g)	73.9	69.4
Minerals (g)	0.6	2.7
Fiber (g)	0.3	1.9
Energy (Kcal)	348	341
Calcium (mg)	23	48
Phosphorous (mg)	121	355
Iron (mg)	2.7	4.9
Carotene (μg)	25	29
Vitamin C (mg)	0	0
Thiamine (mg)	0.12	0.49
Riboflavin (mg)	0.07	0.17
Niacin (mg)	2.4	4.3

Source: DFTQC (2017)

2.5 Ingredient and their role in muffin making

2.5.1 Whole Wheat Flour

Wheat (*Triticum spp*.) originated in the eastern Mediterranean, Near East, and Middle East areas. Wheat is adapted to cool, dry, and temperate climate. In whole wheat flour (WWF) all the anatomical components of the grain, such as endosperm, bran and germ are present in the same proportions that exist in the intact form. Thus, WWF contains substantially more fibers, vitamins, minerals and phytochemicals than refined flour (RF). Accordingly, it is considered as an excellent source of nutritional and functional ingredients for human health with many associated benefits, including the reduction of diseases risk such as diabetes, cardiovascular diseases, obesity, and cancer (R. H. Liu, 2007)

Regardless of the health benefits, WWF might alter the structural and sensory properties of food, lowering consumer acceptance. As a result, making WWF food with the same functionality and quality as refined grain products is difficult. WWF allows for various modifications in dough properties and processing parameters in addition to the qualitative attributes of the final product. The particle size of WWF has a significant impact on the flour's quality and usefulness. (Kihlberg *et al.*, 2004).

(Moder *et al.,* 1984) reported that bread volume was marginally improved by reducing coarse bran particle size. (Noort *et al.,* 2010) reported when the size of the bran particles was reduced, it had a stronger detrimental impact on the baking quality. Cai also found during storage of wheat flour bread with smaller particle size bran, there is a drop in bread volume and a higher degree of starch retro gradation.(Cai *et al.*, 2014)

2.5.2 Fat

Many animal and plant-based diets naturally contain fat. These fats give baked items a lot of attractive qualities like flavor, tenderness, mouth feel, and nutrition..(Kamel and Stauffer, 1993). In bakery goods including muffins, puff pastry, breads, biscuits, scones, and pie crusts, fats like butter, shortenings, or hydrogenated fats are commonly utilized. (Figoni, 2008; Kamel and Stauffer, 1993).

Fats are important ingredients in pastry making. After wheat and sugar, fat is the third and most expensive component in recipes. Water and fat compete with wheat particles and other ingredients during the kneading process. Gluten is formed as a bonded extensible

structure when water interacts with flour protein. When fat is added to flour, the chain is broken, and the result is a crispier, less hard product after baking. (Renzyaeva and Tamara., 2013).

In bakery products, fat serves many functions:

1. Flavor enhancer: This is especially true of animal-based fats, which add richness and distinct flavor characteristics.
2. Texture: mostly less hardness and more softness.
3. Moistness and mouth feel: by coating the tongue and removing grittiness from the food surface.
4. Leavening: introducing air into the creaming and baking process.
5. Delayed staling is caused by fat interfering with the gelatinization of starch.

Source: Figoni (2008)

2.5.3 Sweetening agents

One of the most commonly utilized ingredients in muffins is sugar. Sugar has a hygroscopic property, which means it attracts and holds water molecules. Sugar has this quality which aids in the moistening of baked goods (Gray). Almost all baked items, from chemically leavened sweets to yeasted pastries, contain sugar. It plays an important role in bakery systems, including:

1. Fuel for yeast during fermentation, which produces alcohol and CO2 gas, which is used to leaven dough.
2. Sweetener
3. Humidifier (through its hygroscopic nature)
4. Tenderizing/creaming agent (aerator in batter systems)
5. Increases shelf life by binding free water and lowering water activity (natural preservative)
6. Depression of the freeze-point
7. Texturizer (mouth feel improver)

8. Color and taste enhancer (through browning reactions like Maillard and caramelization)
9. In sponge muffins, foaming agent (together with egg whites)
10. bulking agent

Source: Alexander (1998) (Mariotti and Lucisano, 2014)

2.5.4 Leavening agent

The process of leavening baked goods is when carbon dioxide gas created during yeast fermentation or chemical leavening reactions, or the effect of heat, expands air bubbles that have been integrated into the dough or batter during mixing. The air bubbles expand, causing the batter or dough to expand in size and the cell structure to expand, improving the taste and texture of the final baked product. Air, steam, and carbon dioxide gas are the three primary leavening gases. During the mixing process, air is introduced. When the water in the dough or batter is evaporated during baking, steam is created. Sodium bicarbonate, potassium bicarbonate, and ammonium bicarbonate are the most common donors of carbon dioxide in chemical leavening reactions. During baking, ammonium bicarbonate decomposes to create ammonia gas, carbon dioxide gas, and water. All three of these items are leaveners..(R. Miller, 2016).

The chemical equations for the reaction of soda and the commonly used acidulants are as follows:

$$NaHCO_3 + H^{+`} \longrightarrow Na^+ + CO_2 + H_2O$$

One advantage of ammonia bicarbonate is that it does not generate salts, which can affect the rheology of dough.

$$NH_4HCO_3 \longrightarrow NH_3 + CO_2 + H_2O$$

Source:R. Miller (2016)

The main factors governing the use of chemical aerating agents from a practical point of view are:

1. They should produce adequate amount of CO_2.
2. The residual salts should not adversely affect the quality of resultant goods.

3. They should be harmless.
4. They should not react very readily until the goods enter the oven

2.5.5 Whole Egg

One of the most important elements in sustaining nutritional and physical characteristics of muffin is egg. Eggs are important because their proteins interact with other ingredients to develop the muffin's structure. The emulsifiers in the yolks also aid in the mixing of components that would typically separate, such as water and oil. When heated during baking, those same proteins allow the muffin develop a lovely golden brown tint. The lipids found in egg yolks add to the flavor of any muffin. (Field, 2017)

The carbon dioxide emitted by the baking powder which leavens the food during baking behaves as a nucleus, causing the bubbles created during the mixing process to expand in size. Egg solids, and to a lesser extent egg white, are significant foam stabilizers that hinder the coalescence of air bubbles.(Singh *et al.*, 2017)

2.5.6 Water

Water, a simple chemical element, is just as crucial as flour in the cooking and baking process. It has a variety of functions in baking processes, some of which are unclear, while others are determined by the properties of the finished product. The water must be drinkable to be utilized in baking operations, regardless of its source. The mineral composition of water can impact dough properties. Water can have a role in achieving the ideal dough and final product properties. Three aspects of water quality that must be considered are reviewed. They are: flavor, chemical composition, and mineral content. (Sinani *et al.*, 2014).

The functions of water are as follows:

1. Give moisture to the products.
2. Combines all the dry ingredients together.
3. Builds structure of the baked products.
4. Controls the batter and dough temperature and improves the keeping quality.
5. Controls the consistency of the dough and batter and affects the volume and texture of muffins

2.6 Baking Profile

Baking is the most crucial stage in muffin manufacture since without it, the product loses its taste. The product is cooked, the flavor and color are produced, and the unprocessed dough is converted into an edible snack known as a muffin during baking. The primary goal of baking is to remove excess moisture from the dough by steadily heating it. (Bloksma, 1990). Every baking procedure relies on heat transfer from a hot source to the baked result. Conduction, convection, and radiation are the three main methods of heat exchange during baking. During baking, radiation makes up the majority of heat transfer to the dough pieces, with convection providing only a small portion of the heat transfer. If the air velocity in the tunnel is more than 5 feet per second, convection heat transmission increases. Apart from these three heat transmission modalities, high frequency heating is also used, which has a faster moisture removal rate. (Smith, 1972).

Every oven used till date consists of four basic parts.

1. A heat source
2. A base (sole or hearth), capable of being heated, on which the dough piece is placed.
3. A cover over the base, making up a chamber in which to retain the heat.
4. A closable opening through which the dough piece can be put into and taken from the baking chamber.

During baking the dough undergoes gradual changes physically as well as chemically. Physical changes include:

1. Formation of a film crust on the dough.
2. Melting of the fat in the dough.
3. Gas release and volume expansion.
4. Conversion of water into steam.
5. Escape of carbon dioxide, other gases and steam.
6. Chemical changes include:
7. Gas formation

8. Starch gelatinization
9. Protein changes
10. Caramelization of sugar
11. Dextrinization

Temperature in the baking oven has different effect on the raw dough, which is shown in Table 2.4.

Table 2.4 Temperature related changes in muffin during baking

Temperature (˚F)	Changes occurred
90-100	Skin development on the top crust (Evaporation of surface moisture).
90-120	CO_2 evolution within crumb (Less solubility of CO_2).
90-150	CO_2 Gas expansion causes a volume increase (CO_2 and steam).
90-210	Gelatinization of starch (Muffin structure).
125-210	Protein coagulation (Irreversible).
170-250	The process of dextrinization (surface gloss)
370-400	Skin development on the top crust (Evaporation of surface moisture).

Source: Mukhopadhyay (1990)

More steam is required in the oven during baking than is produced by the moisture in the dough and the combustion of the fuel. Steam introduced into the baking chamber at the time of dough entry or very early in their passage through the oven aids in the production of a shining crust, the avoidance of broken crusts, increased volume, and to some extent agitation of the oven atmosphere. The use of fast moving fans recirculating air at speeds of 2000 cu ft. per minute can eliminate the necessity for steam injection. The dampers in the ovens are important for releasing the strong positive pressure caused by high heat evaporation; similarly, if high moisture cookies or biscuits are wanted, the dampers in the last zone must be closed. (Smith, 1972).

Part-III

Materials and methods

3.1 Materials

3.1.1 Whole Wheat Flour

Whole Wheat Flour (*Atta*), *(Gyan Chakki Atta)* manufactured by KL Durga Group was brought from local market of Dharan.

3.1.2 Dates Powder

Dates were brought from local market of Asan, Kathmandu. It was later converted into powder form in dry pilot plant of Central Campus of Technology, Dharan.

3.1.3 Sugar

Sugar was brought from local market of Dharan.

3.1.4 Fat

Butter, produced by Dairy Development Corporation, Biratnagar, was brought from local market of Dharan.

3.1.5 Egg

Eggs were brought from local market in Dharan.

3.1.6 Baking powder

'Weikfied baking powder double action' manufactured and packed by Weikfied food Pvt. Ltd., Pune, India was brought from supermarket of Dharan.

3.1.7 Water

Water was available in Central Campus of Technology, Dharan.

3.1.8 Equipment and chemicals

Equipment and chemicals used were available in Central Campus of Technology, Dharan.

3.2 Methods

3.2.1 Experimental procedure

Design-Expert® v 13.0.1.0 was used to create the experimental design (D-optimal, 2 factors, and 5 Runs). Table 3.3 shows the experimental plan for Response Surface analysis. There were 5 levels of date powder (0, 12.5, 25, 37.5, 50 parts) and 5 levels of sugar (100, 87.5, 75, 62.5, 50 parts) were used respectively. The experimental plan contains the details of the runs (Table 3.1)

Table 3.1 Experiment plan for response surface analysis (Format generated by Design Expert® v13.0.1.0)

Standard	Run	Component A A: Date powder%	Component B B: sugar%
2	4	0	100
5	2	12.5	87.5
3	5	25	75
4	1	37,5	62.5
1	3	50	50

3.2.1.1 Formulation of recipe

The recipe for date powder substituted muffins were carried out as per table 3.2. The amount given is on different basis:

Table 3.2: Recipe for muffins

Ingredients	A	B	C	D	E
Whole Wheat Flour	100 g	100 g	100 g	100 g	100 g
Sugar	55 g	48.1 g	13.8 g	20.7 g	27.5 g
Date Powder	0 g	6.9 g	41.2 g	34.3 g	27.5 g
Fat	55 g	55 g	55 g	55 g	55 g
Egg	57 g	57 g	57 g	57 g	57 g
Baking Powder	3 g	3 g	3 g	3 g	3 g
Water	10 ml	10 ml	10 ml	10 ml	10 ml

The muffin was made as per the recipe formulation and coded A, B, C, D and E.

3.2.1.2 Date powder Preparation

The date powder was prepared following procedure given by Sablani *et al*, 2008 with some modification. Pitted and washed dates were used. Before steaming, pitted dates were chopped into little pieces and placed in baking trays. These trays were placed in the oven and dried for 24 hours at a low temperature of 65 °C. The dates were pulverized in electric grinder after drying. Date powder was ground and packaged in an airtight container. The use of high-molecular-weight carrier agents or drying aids (maltodextrin and gum Arabic) can help to minimize stickiness and raise the powder's glass transition temperature but due to unavailability of maltodextrin, we were not able to add it. After grinding, date powder was packed air tight packaging.

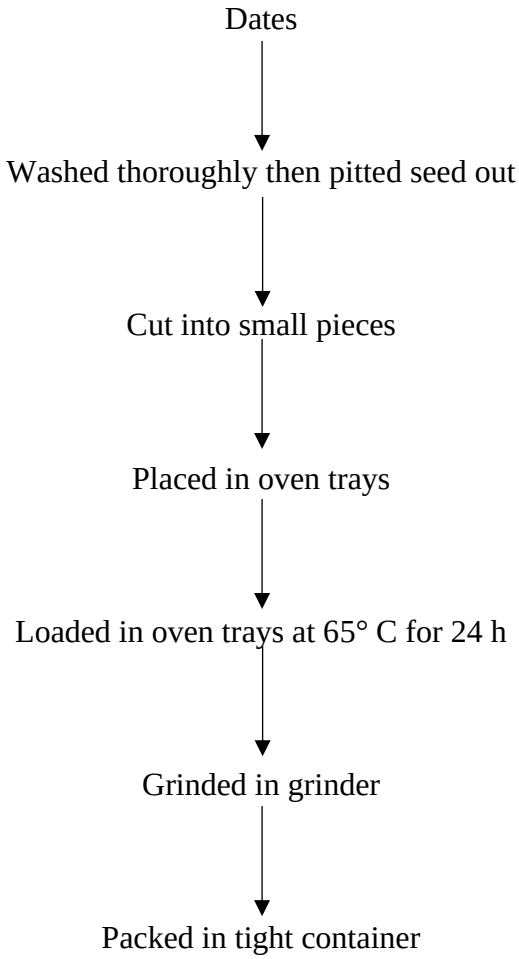

Fig 3.1- Preparation of date powder

Sources: Sablani *et al.* (2008)

3.2.1.3 Preparation of date powder substituted muffins

Five distinct muffin recipes were generated in this study. Table 3.1 illustrates that one formulation was prepared without date powder (control) and four others were prepared with date powder at varying amounts. The first step was to separate the dry and wet ingredients. Wheat flour, date powder, baking powder, and sugar were among the dry ingredients. Egg, water, and butter were the wet ingredients. Before combining the water and oil, the egg was whisked for 2 minutes properly. All dry ingredients were thoroughly mixed in a separate bowl. The dry and wet ingredients were then blended together to yield a mixed muffin batter.

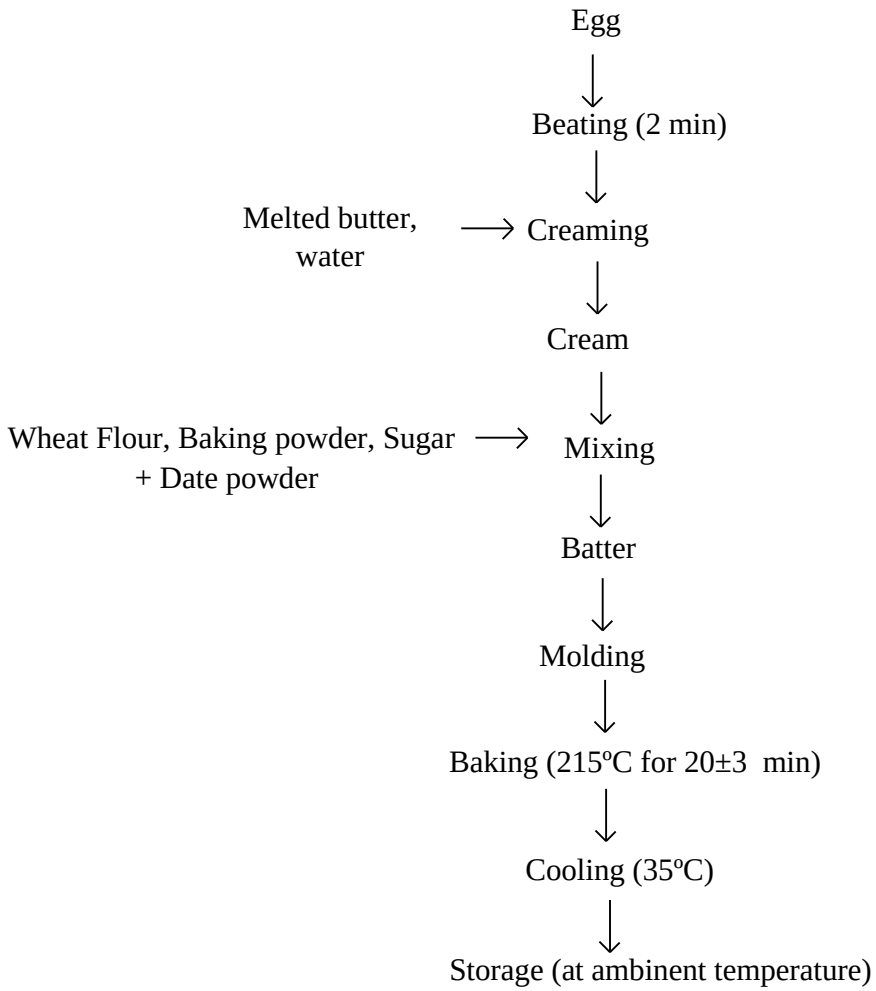

Fig.3.2 Flow chart for the preparation of date powder substituted muffin

Source: Rahman *et al.* (2015)

3.2.1.4. Muffin baking process

3.2.4.1. Mixing

The primary objective of mixing is to achieve a homogenous mixture; generally, this means, attaining a nearly uniform distribution of the ingredients. A distinction may be drawn between batch and continuous process. Overall, the concentration of the ingredient should uniformly be distributed in the output stream, should not vary with time and the processing of each part of mixture should be same(Ashokan *et al.*, 2013).

3.2.4.2. Baking

The batter should be placed in mold then baked as quickly as possible after being mixed. Muffin batters that are not to be baked immediately should be covered tightly with plastic wrap and refrigerated until the batter is to be baked in the oven. Once the baking powder has entered the solution, some carbon dioxide is evolved. If the mixture is left standing for prolonged periods, some of the carbon dioxide will escape and the baked product will have a characteristically coarse cell structure (Trimbo and Miller, 1966).

3.2.4.3 Cooling

After taking out muffin from oven, it is cooled to room temperature before packing. During cooling moisture moves from interior outward towards the crust and to atmosphere, if the moisture content of the crust rises considerably during cooling, the texture of the crust becomes leathery and tough and attractive crispness of freshly baked muffin is lost. Excessive drying during cooling results in weight loss and poor crumb characteristics. The aim of cooling is to lower the temperature without much loss of moisture (N. L. Kent, 1983). On cooling, sugar in the muffin imparts strength and stiffness to the product.

3.2.2 Analytical procedure

3.2.2.1 Moisture content

Moisture content of raw material and product was determined by using a hot air oven as per described by (KC and Rai, 2019)

$$\text{Moisture Content} = \frac{(W_{initial} - W_{final})}{W_{initial}} \times 100\%$$

Where, $W_{initial}$ = weight of sample before drying

W_{final}= weight of sample after drying

3.2.2.2 Crude fat

Crude fat in raw material and product was determined by soxhlet extraction method as per described by (KC and Rai, 2019).

$$\text{Crude fat} = \frac{(W_2 - W_1)}{W} \times 100\%$$

Where, W_1 = weight of beaker

W_2 = weight of oil extracted + beaker

W = weight of sample

3.3.3 Crude protein

Crude protein (N × 6.25) in raw material and product was determined by micro kjeldahl method as per (KC and Rai, 2019).

$$\text{Protein content (\%, wb)} = \frac{(sample - blank) \times N\ of\ HCl \times 14 \times 100 \times 100}{Aliquot\ (ml) \times wt.of\ sample\ (g) \times 1000}$$

3.3.4 Total ash

Total ash was determined by dry ashing method as per (KC and Rai, 2019).

$$\text{Ash content} = \frac{W_3 - W_1}{W_2 - W_1} \times 100\%$$

Where, W_1 = weight of empty crucible

W_2 = weight of sample + crucible before ashing

W_3= weight of sample + crucible after ashing

3.3.5 Crude fiber

Crude fiber was determined by using chemical process, the sample was treated with boiling dilute sulphuric acid, boiling sodium hydroxide and then with alcohol, under standardized condition as per (KC and Rai, 2019).

$$\text{Crude fiber (\%, wb)} = \frac{(Residue - Ash)g \times (100 - F)}{sample\ (g)}$$

3.3.6 Carbohydrate

Total carbohydrate content was determined.by difference method as per (KC and Rai, 2019).

Carbohydrate (%) = 100-(protein + fat + ash + crude fiber)

3.3.7 Acid value and Peroxide value

Peroxidation of muffin lipid was determined by the measurement of peroxide value (PV) and acid value (AV) of stored muffin at room temperature according to the methods (KC and Rai, 2019)

Acid value (as oleic acid) = $\frac{ml\ of\ alkali \times N\ of\ alkali \times 28.2}{weight\ of\ sample\ (g)}$

Peroxide Value = $\frac{N \times (V_s - V_b) \times 1000}{wt.of\ sample\ (g)}$

Where, N= N of sod. Thiosulfate

Vs = sod. Thiosulfate consumed by sample in ml

V_b = sod. Thiosulfate consumed by blank in ml

3.3.8 Volume

Loaf volume of muffin was determined by mustard seed displacement method putting the muffin in a beaker of known volume. A box of known volume will be filled with seed and the weight of seed required to just fill the box is noted. The sample is introduced and the seed poured back into the box. The volume of seed displaced is equal to the volume of the product (AACC, 2000).

3.3.9 Weight of muffin

Weight of the muffin was measured with the help of a weighing balance available Central Campus of Technology, Dharan (AACC, 2000).

3.3.10 Specific loaf volume

Specific loaf volume of muffin was calculated by dividing the Volume by Weight (AACC, 2000).

Specific loaf volume = $\frac{weight\ of\ muffin}{volume\ of\ muffin}$

3.2.3 Sensory analysis

Semi-trained panelists comprised of Central Campus of Technology teachers and students conducted the sensory analysis for overall quality. Texture, appearance, color, taste, smell, flavor, and overall acceptability were the sensory evaluation parameters. The 9-Point Hedonic Scale was used to undertake sensory evaluations (see appendix A).

3.2.4 Acceptability period of muffin

Acceptability period of the product was determined by acid value, peroxide value of the extracted fat of the muffin. The analysis was carried out for 7 days.

3.2.5 Microbiological analysis

Pour plate technique was used to determine Total Plate Count (TPC) on Plate Count Agar (PCA) medium (incubated at 30°C for 48 hours). On MacConkey media (incubated at 37°C for 48 hours), the coliform count was measured using the pour plate technique. (AOAC, 2005).

3.2.6 Statistical method

The gathered data was statistically analyzed using Genstat Discovery Edition 12 for Analysis of Variance (ANOVA) at a significance level of 5%. The data from the proximate analysis and sensory evaluations were subjected to one and two way ANOVA.

Part IV

Results and Discussion

Dates were purchased at the market and converted date powder in the pilot plant. Then, prepared date powder and brought whole wheat flour were both evaluated for proximate analysis. The muffins were made using the muffin mixing method with different proportions of sugar and date powder in the ratios of 0:100, 12.5:87.5, 25:75, 37.5:62.5,50:50,and were coded as samples A, B, C, D, and E respectively. Muffin samples had their physical properties determined. The muffins were then subjected to sensory examination, with the mean score for each sample calculated. The best product was chosen, and the control and best product were compared in terms of proximity and cost. The best product's shelf life was also assessed.

4.1 Analysis of materials

In the preparation of date powder substituted muffin, date powder and whole wheat flour were the major ingredients. They were analyzed for their composition. The proximate composition of date powder and Whole Wheat flour is presented in Table 4.1.

Table 4.1 Proximate analysis of WWF and Date powder:

Parameters	WWF (%)	Date powder (%)
Moisture	11.22±0.8	15.9±0.04
Protein (N×6.25)	14.09±0.21	2.4±0.3
Fat	1.2±0.05	0.5±0.05
Crude fiber	2.01±0.03	5.5±0.34
Ash	2.02±0.3	2.3±0.08
Carbohydrate	69.46±0.26	72.9± 0.03

Values are the means of triplicates. (±) Figures are the standard deviation

4.1.1 Chemical composition of wheat flour

The moisture content, protein, fat, crude fiber, ash and carbohydrate of whole wheat flour were found to be 11.22, 14.09, 1.2, 2.01, 2.02, 69.46. According to (DFTQC, 2012), proximate values were 12.2, 12.1, 1.7, 1.9, 2.7, 69.4. There is difference in standard vale and

calculated value. The difference in proximate composition may be due to factors like varieties, climatic conditions, soil type, maturity, fertility and others.

4.1.2 Chemical composition of date powder

The moisture content, protein, fat, crude fiber, ash and carbohydrate of whole wheat flour were found to be 15.9, 2.4, 0.5, 5.5, 2.3, 72.9 respectively and standard proximate were 15.3 2.5, 0.4, 3.9, 2.1 and 75.8 respectively (DFTQC, 2012). The difference in proximate composition may be due to factors like varieties, climatic conditions, soil type, maturity, fertility and others.

4.2 Physical analysis of muffin

The physical analysis is carried out to determine the effect of date powder on the muffin structure. Weight, volume, and specific loaf volume are all considered. For each physical parameter, five values are taken and a graph is displayed.

4.2.1 Result of incorporation of date powder in muffin for volume during baking

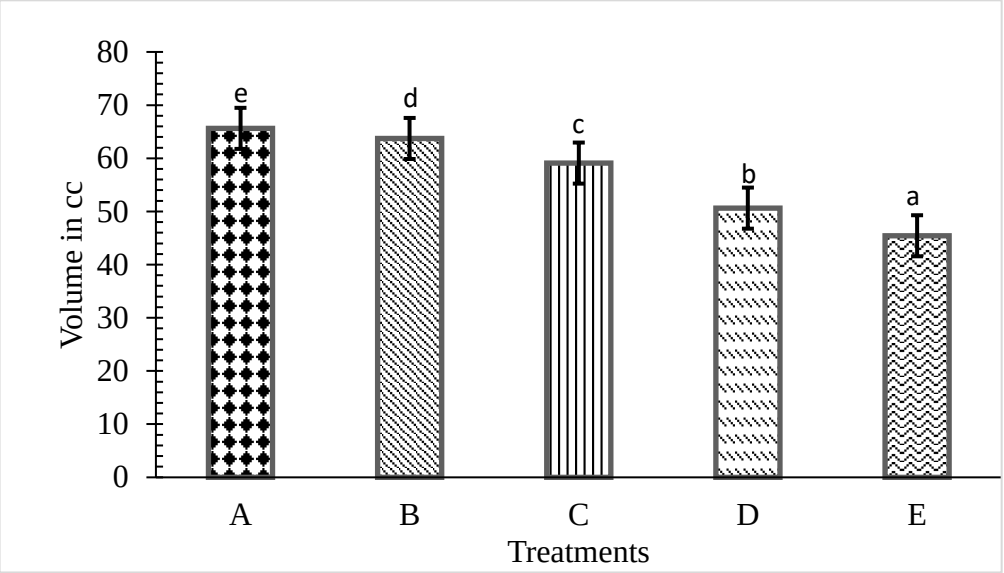

Fig. 4.1 Change in volume during baking at different proportions of date powder

In Fig. 4.1, the obtained volume mean values are displayed as a bar diagram. There is a significant difference in volume within the sample ($p \leq 0.05$), according to the ANOVA table (Table C.1, Appendix C). Similarly, alphabet above the bar graph indicates significant difference and error bars shows standard deviation of triplicates.

The most important individual quality parameter utilized for muffin evaluation is the loaf volume. It is a quantitative statistic that is linked to dough handling characteristics, crumb, texture, freshness, and technical adaptability (Karim, 2012). When compared to a control muffin with a loaf capacity of 65.63(±0.25) cm^3, date powder substituted muffins had significantly lower loaf volume. The volume of sample B, C, D and E muffins were 63.73(±0.35), 59.1(±0.36), 50.63(±0.056), 45.63(±0.157) cm^3 respectively. The volume of sample B, C, D and E was found to be lesser than the normal muffin which might be due to incorporation of date powder which is high in fiber.

Thus, it was observed that higher level of date powder substitution had a negative effect on the volume of muffin. This finding is in agreement with (Struck *et al.*, 2016) who reported that increase in dietary fibers, decrease the volume of the sweet bakery products. Thus, decrease in volume is due to the increase in fiber amount which has high water binding capacity.

4.2.2 Result of incorporation of date powder in muffin for weight during baking

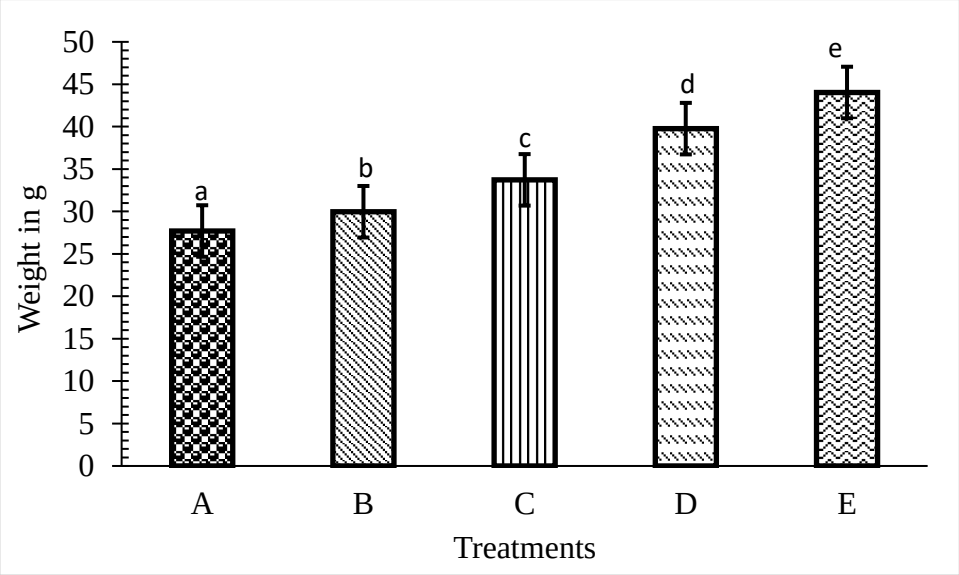

Fig. 4.2 Change in weight during baking at different proportions of date powder

In Fig. 4.2, the obtained weight mean values are presented as a bar diagram. There is a significant difference in weights within the sample ($p \leq 0.05$), according to the ANOVA table (Table C.2, Appendix C). Similarly, alphabet above the bar graph indicates significant difference and error bars shows standard deviation of triplicates.

The control muffin (27.7± 0.58 g) had the smallest loaf weight, which rapidly grew in date powder replaced muffins. The weight of sample B, C, D and E are 29.97(±0.21), 33.73(±0.15), 39.77(±0.15), 44.03(±0.21) g respectively. The experimental sample E produced the highest value of loaf weight which may be due to high fiber content in the sample.

Date powder as well as whole wheat flour are high in fiber, which contributes to its dense structure. The increased mass in sample E could be attributed to the presence of more crude fiber. The fiber traps the water, contributing to the E coded muffin's higher weight.(S. P. Cauvain and Cyster, 1996)

4.2.3 Result of incorporation of date powder in muffin for specific loaf volume during baking

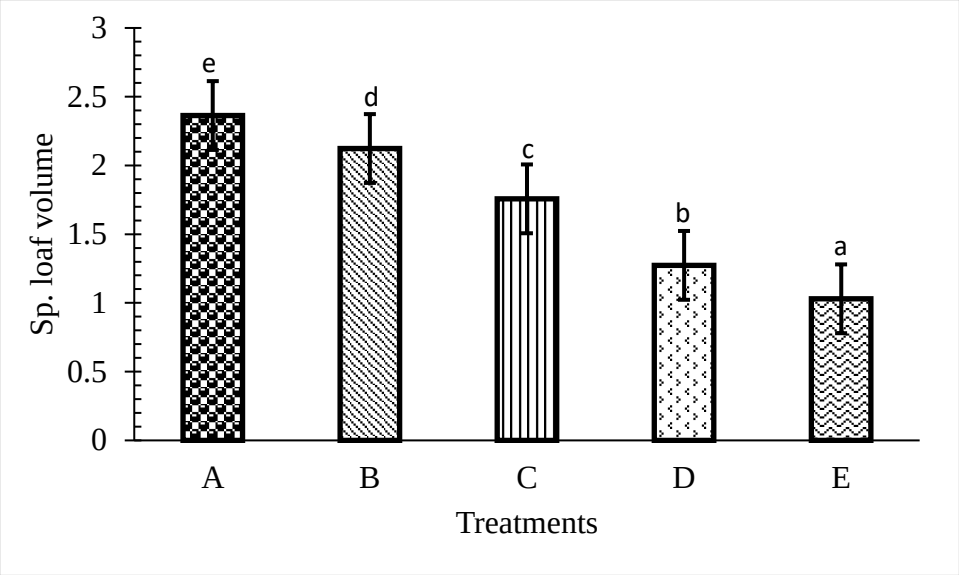

Fig. 4.3 Change in sp. Loaf volume during baking at different proportions of date powder

In Fig. 4.3, the obtained mean values for specific loaf volume are shown as a bar diagram. There is a significant difference in specific loaf volume within the sample ($p \leq 0.05$), as per ANOVA table (Table C.3, Appendix C). Similarly, alphabet above the bar graph indicates significant difference and error bars shows standard deviation of triplicates.

In the literature, the specific volume, which is the ratio of the two qualities, namely loaf volume to loaf weight, has been widely accepted as a more trustworthy indicator of loaf size. Specific loaf volume is a significant criterion for evaluating bakery product quality, as it is directly influenced by the product's volume and weight. Particle size, weight, water content,

gluten content, and fiber content all influence weight and volume.(Noor Aziah and Komathi, 2009). The specific volume of the control muffin (100% sugar containing muffin) was 2.363 ml/g and the same for the experimental variation Sample B was 2.122 ml/g, sample C was 1.757 ml/g, sample D was 1.273 ml/g and sample E was 1.03 ml/g. Since loaf volume got decreased and weight got increased in the present study, their ratio, i.e., the specific volume also decreased significantly in variants muffins when compared to the control muffins .Thus, the result showed that specific loaf volume decreases when the amount of date powder was increased.

4.3 Sensory evaluation of muffin

Sensory evaluation of muffins made with various levels of date powder incorporation according to recipes was done. Color, smell, look, texture, taste, and general acceptability of the samples were assessed using the hedonic rating system (1 = dislike extremely, 9 = like extremely) (Rangana, 1986). Ten panelists were presented the samples. The panelists were taught to evaluate their sensory evaluations in respect to several muffin parameters. It was suggested that the panelist produce score sheets based on their perception. Appendix B contains the ANOVA table for sensory evaluation of panelists on sugar and date powder variations.

Here, A is 100% sugar containing muffin, B is muffin with 12.5 % date powder and 87.5% sugar, C is muffin with 25% date powder and 75% sugar, D is muffin with 37.5% date powder and 62.5% sugar and E is muffin with 50% date powder and 50% sugar.

4.3.1 Appearance

The mean score for the appearance were 8.2, 7.8, 6.7, 6.6 and 6.5 respectively for sample A, B, C, D and E. The obtained mean values are represented as bar diagram in Fig. 4.4. There is a significant difference in appearance within the sample ($p \leq 0.05$), according to the ANOVA table (Table B.2, Appendix B).

On the basis of mean score with respect to appearance, the superiority/inferiority ($p \leq 0.05$) of the muffin samples was found to rank as follows:

[A] > [B] > [C] > [D] > [E]

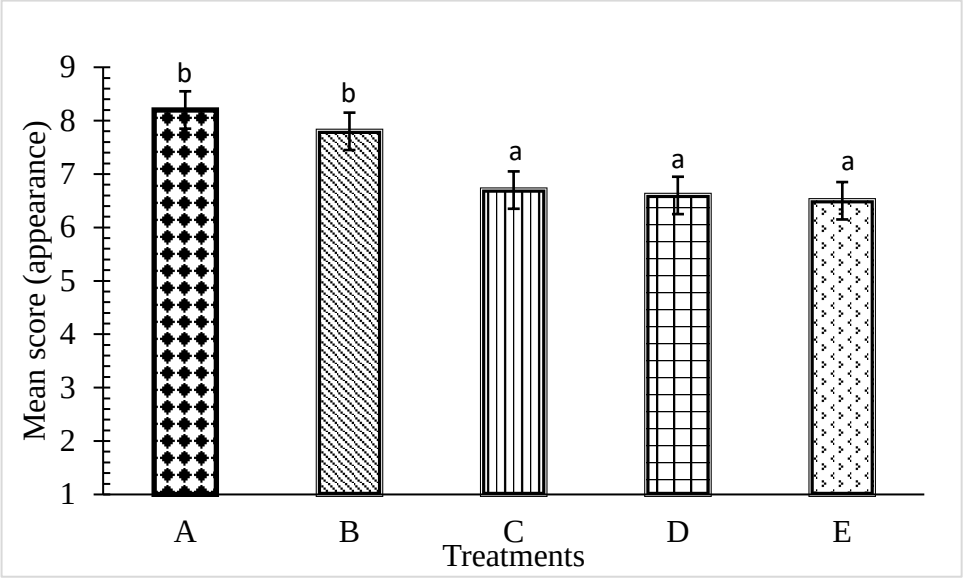

Fig: 4.4 Characteristics of product with respect to appearance

Similarly, the alphabet above the bar graph denotes a significant difference. Sample B received the highest score for appearance, followed by the other product formulations. Statistical analysis showed that partial substitution of sugar with date powder had significant effect ($p<0.01$) on the appearance of the different muffin formulations. The product A and B were not significantly different to each other but significantly different to others while product C, D and E were not significantly different to each other but were from A, B which is shown graphically in Fig 4.4. The off brown color of samples (except A) is due to date powder, which is maybe disliked by panelists.

This can be due to increase in dietary fiber in the date powder substituted samples. Due to water binding property of fibers, the whole wheat flour was not able to bind with required amount water and as the result, the volume of muffins were not up to the mark.

4.3.2 Color

The mean score for the color were 6.7, 7.9, 8.3, 6.6 and 6.5respectively for sample A, B, C, D and E. The obtained mean values are represented as bar diagram in Fig. 4.5. There is a significant difference in color within the sample ($p\leq0.05$), according to the ANOVA table (Table B.2, Appendix B).

On the basis of mean score with respect to color, the superiority/inferiority ($p\leq0.05$) of the muffin samples was found to rank as follows:

[C] > [B] > [A] > [D] > [E]

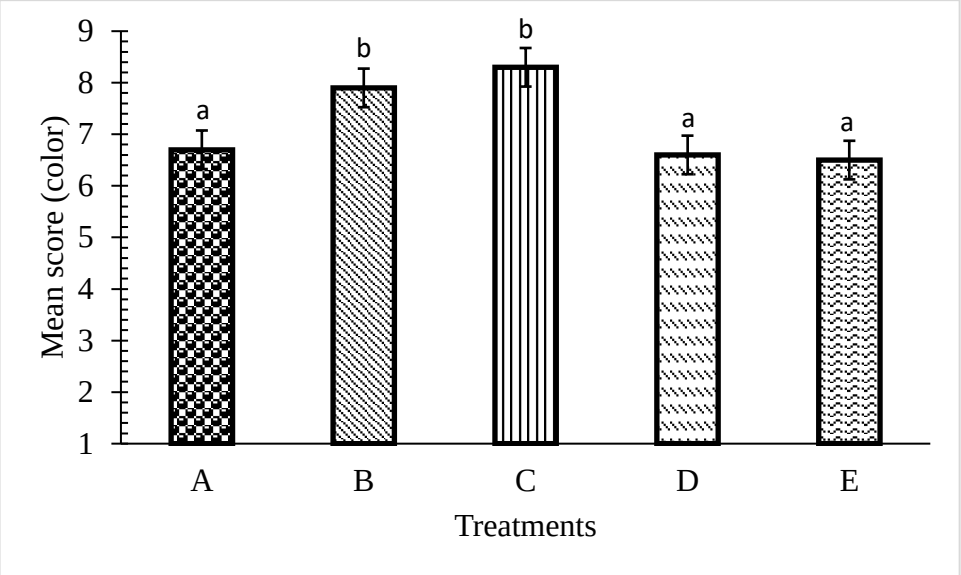

Fig: 4.5 Characteristics of product with respect to color

Similarly, the alphabet above the bar graph denotes a significant difference. Sample A received the highest score for color, followed by the other product formulations. Statistical analysis showed that partial substitution of sugar with date powder had significant effect ($p<0.01$) on the color of the different muffin formulations. The product A and B were not significantly different to each other but significantly different to others while product C, D and E were not significantly different to each other but were from A, B which is shown graphically in Fig 4.5.

Sample C has the highest score as its color is due to date powder and caramelization of sugar. The color was brown and liked by most of panelists. But as the date powder increase, the brown color got deepened and seems like burnt color so, sample E has lowest score.

4.3.3 Flavor

The mean score for the flavor were 8, 8.2, 6.4, 6.7 and 6.7 respectively for sample A, B, C, D and E. The obtained mean values are represented as bar diagram in Fig. 4.6. There is a significant difference in flavor within the sample ($p\leq0.05$), according to the ANOVA table (Table B.3, Appendix B).

On the basis of mean score with respect to flavor, the superiority/inferiority ($p\leq0.05$) of the muffin samples was found to rank as follows:

[B] > [A] > [C] > [D] > [E]

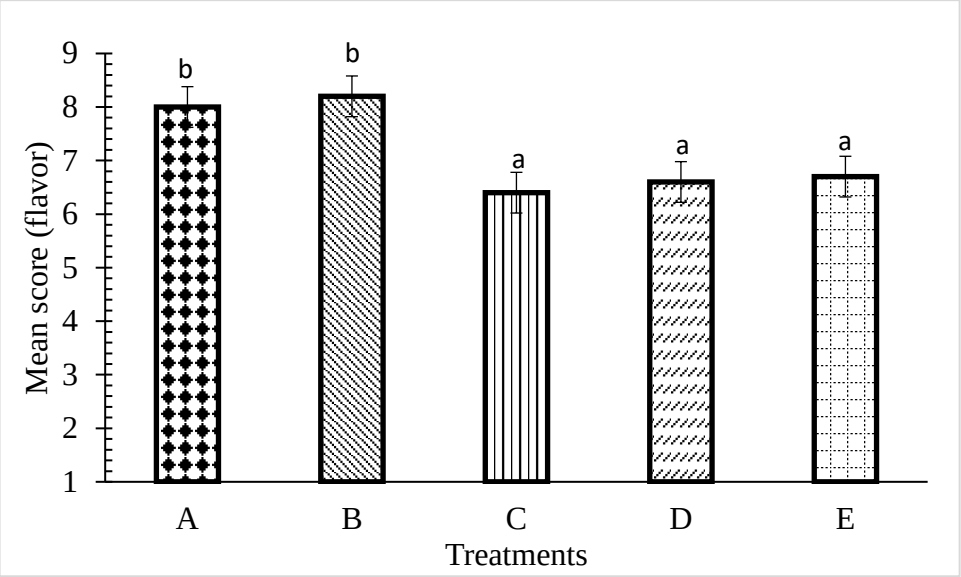

Fig: 4.6 Characteristics of product with respect to flavor

Similarly, the alphabet above the bar graph denotes a significant difference. Sample B received the highest score for flavor, followed by the other product formulations. Statistical analysis showed that partial substitution of sugar with date powder had significant effect ($p<0.01$) on the smell of the different muffin formulations. The product A and B were not significantly different to each other but significantly different to others while product C, D and E were not significantly different to each other but were from A, B which is shown graphically in Fig 4.6. This might be due to incorporation of date powder. But, increasing the amount of date powder has negative effect.

4.3.4 Texture

The mean score for the texture were 7.8, 8.0, 6.4, 6.7 and 6.7 respectively for sample A, B, C, D and E. The obtained mean values are represented as bar diagram in Fig. 4.7. There is a significant difference in texture within the sample ($p\leq0.05$), according to the ANOVA table (Table B.2, Appendix B).

On the basis of mean score with respect to texture, the superiority/inferiority ($p\leq0.05$) of the muffin samples was found to rank as follows:

[B] > [A] > [C] > [D] > [E]

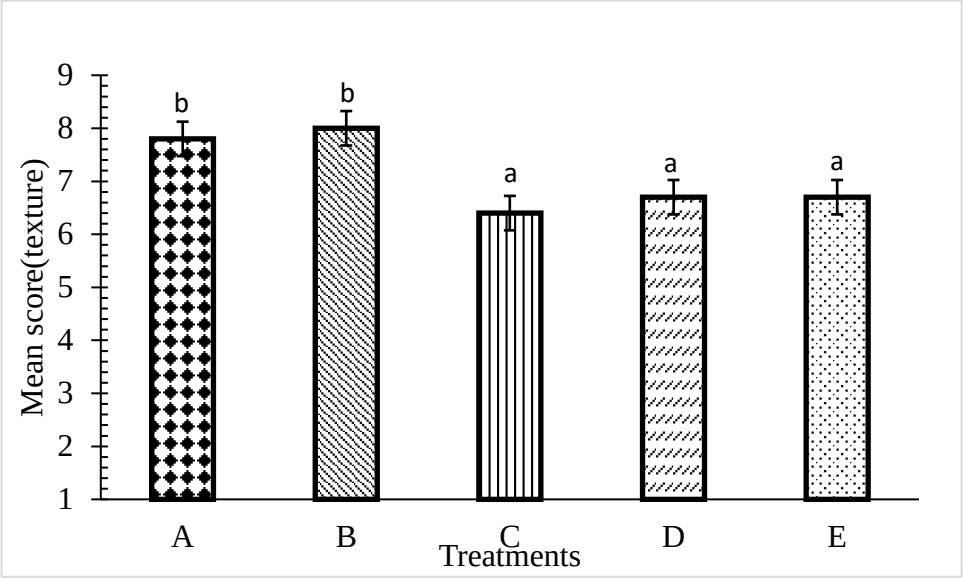

Fig: 4.7 Characteristics of product with respect to texture

Similarly, the alphabet above the bar graph denotes a significant difference. Sample B received the highest score for texture, followed by the other product formulations. Statistical analysis showed that partial substitution of sugar with date powder had significant effect ($p<0.01$) on the texture of the different muffin formulations. The product A and B were not significantly different to each other but significantly different to others while product C, D and E were not significantly different to each other but were from A, B which is shown graphically in Fig 4.7.Due to water binding capability of date powder, excess adding results stiff, tough texture of the muffins but adding small quantity of date powder as in B, gives spongy and light texture to muffins.

4.3.5 Overall acceptability

The mean score for the overall acceptability were 7.9, 8.2, 6.5, 6.7 and 6.6 respectively for sample A, B, C, D and E. The obtained mean values are represented as bar diagram in Fig. 4.8 There is a significant difference in overall acceptability within the sample ($p\leq0.05$), according to the ANOVA table (Table B.2, Appendix B).

On the basis of mean score with respect to overall acceptability, the superiority/inferiority ($p\leq0.05$) of the muffin samples was found to rank as follows:

[B] > [A] > [C] > [D] > [E]

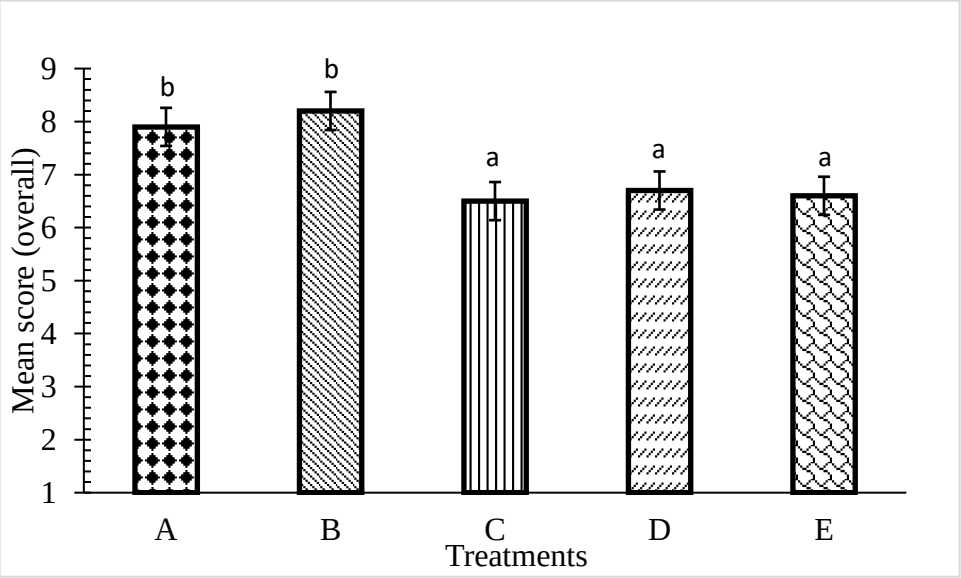

Fig: 4.8 Characteristics of product with respect to overall acceptability

Similarly, the alphabet above the bar graph denotes a significant difference. Sample B received the highest score for overall acceptability, followed by the other product formulations. Statistical analysis showed that partial substitution of sugar with date powder had significant effect ($p<0.01$) on the overall acceptability of the different muffin formulations. The product A and B were not significantly different to each other but were significantly different to others while product C, D and E were not significantly different to each other but were from A, B which is shown graphically in Fig 4.8.

On the basis of overall acceptability sample B was found to be best. It was found that increasing the amount of date powder beyond 12.5% reduced the acceptability of the muffins. The highest overall sensory score was obtained when date powder was used at 12.5% addition level. This muffin had desirable smell, texture and taste. While, increasing amount of date powder reduced texture, smell and taste of muffins so, they have low acceptability.

4.4 Chemical composition of muffin

The proximate compositions of control muffin and best sample (12.5% date powder muffin) incorporation were analyzed and obtained results are given in Table 4.3

Table 4.3 Proximate composition of control and best muffins

Parameters	Control muffin (%)	Date powder muffin (%)
Moisture	15.6 ± 2.3	16.18±1.09
Protein	6.92 ± 1.81	7.03±0.65
Fat	23.7 ± 2.2	23.72±1.98
Fiber	4.67 ± 0.44	6.18±0.67
Total ash	1.87±0.005	1.95±0.98
Carbohydrate	44.87±0.09	44.94±0.91

Here, Control muffin which is whole wheat muffin was coded as A and Date powder muffin which is the best product was coded as B. The moisture content of the whole wheat flour muffin was found to be lower than the date powder substituted muffin. This could be due to the ability of the date powder to absorb more water than that the sugar. The protein content of the date powder substituted muffins were higher than that of whole wheat flour muffin as it contains date which has certain protein in it. Fiber content and ash content were higher in date powder substituted muffins than that of whole wheat flour muffin. Dates are considered as the best source as fiber and minerals. Individuals who regularly take fiber rich food have lower risk of cardiovascular disease compared to individuals who do not consume adequate quantity of fiber (Vasishtha and Srivastava, 2011). The muffins have appreciable fiber content which may be due to higher fiber content in dates. Fat content was higher in date powder substituted muffins than that of whole wheat flour muffin.

4.5 Shelf life evaluation of the date powder substituted muffin

A common practice to evaluate the shelf life of the given product is to determine the changes in the selected quality characteristics over the period of time. For, shelf life evaluation best product muffins were kept in LDPE and stored at ambient temperature (27°C). The acid value (AV) and peroxide value (PV) of extracted fat from the muffin were evaluated to determine shelf life of muffins.

4.5.1 Change in Acid Value

The fat from the prepared muffin was retrieved and was taken to a lab to be tested for acidity. The acid value was found to be 0.17 mg KOH/g on the first day. It is raised to 0.19 mg KOH/g the next day. In the same way, it progresses in increasing order until it reaches 0.23 mg KOH/g, 0.27mg KOH/g, 0.32 mg KOH/g, 0.39 mg KOH/g, 0.48 mg KOH/g, and 0.62 mg KOH/g on the 3rd , 4th , 5th , 6th, 7th and 8th days were measured respectively. The acid value should not be more than 0.50 mg KOH/g (Pearson *et al.*, 1981). So, after that, because the acid value of 7 days of storage exceeds the maximum limit, it is not acceptable. So, after 7 days the PV exceeds the maximum limit and thus is not acceptable for human consumption. A normal muffin has shelf life of 2-7 days and the muffin prepared has date in it and date is said to increase the shelf life of product.

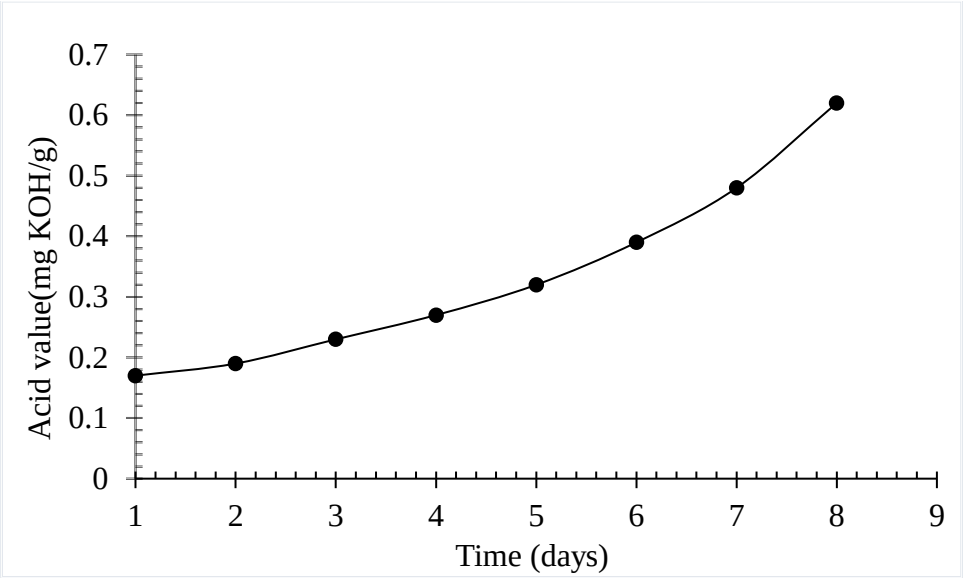

Fig. 4.9 Changes in Acid value with respect to number of days of storage

According to (Kishk, 1997), the oxidation of double bonds in unsaturated fatty acid esters can yield free fatty acids. The accumulation of acidic cleavage produced free fatty acids with low molecular weight at an advanced stage of oxidation. As a result of which the acid value increased. As with all fat-containing foods, muffin is subject to spoiling due to the auto-oxidation of unsaturated and saturated fats. Oil contains polyunsaturated fats. Lipase activity is indicated by the amount of free fatty acids in oil. The presence of the enzyme lipase, as well as any other hydrolytic activity. As a result of the increase in free fatty acid content,

which is evaluated by the acid value, the extent or proneness to rancidity in cake grows as the storage period increases.

4.5.2 Change in Peroxide Value

The fat from the baked muffin was removed and subjected to peroxide analysis. The peroxide value was determined to be 1.17 meq/kg on the first day. The following day, it was discovered to be 1.62 meq/kg. It also increases in order, reaching 2.42 meq/kg, 3.98 meq/kg, 5.23 meq/kg,7.51 meq/kg, 9.42 meq/kg, and 11.21 meq/kg on the third, fourth, fifth, sixth, seventh and eighth days, respectively. (Pearson *et al.*, 1981) defined rancidity as a peroxide value more than 10 meq/kg. As a result, after 7 days, the PV has exceeded the maximum limit and therefore, muffin becomes unfit for human consumption.

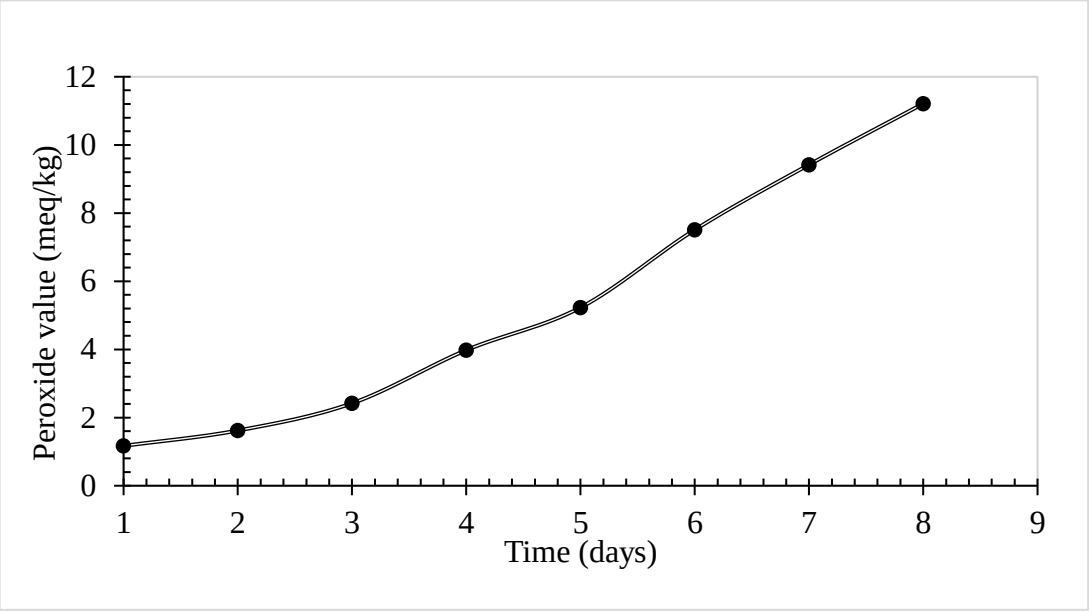

Fig. 4.10 Changes in Peroxide value with respect to number of days of storage

The peroxide value of fat shows the degree of primary oxidation and, as a result, the likelihood of it becoming rancid. Autoxidation is a free radical reaction involving oxygen that causes fats and oils to deteriorate. Peroxides are intermediates in this reaction. Hydro peroxides, also known as primary oxidation products, are flavorless but unstable intermediates that decompose into volatile decomposition products such as aldehydes, ketones, alcohols, and acids, as well as various secondary oxidation products that cause off-flavoring in oils.(Kaleem *et al.*, 2015).

4.6 Microbiological analysis of product

The product B was kept in packaging material i.e. LDPE. Then that was kept in normal atmospheric condition for microbiological analysis for 7 days. The total plate count (TPC) of the stored muffin was analyzed. There were no colonies of coliform found. They were destroyed during the baking of muffin before packaging. Also there were no any colony of yeast and mold up to 7 days.

4.7 Cost evaluation

The total cost associated with the best product was calculated and the cost of date powder substituted muffin was NRs. 43.46/ 100 g including overhead cost and profit of 10% each. From the cost calculation given in appendix E, it can be seen that due to the high cost of date powder to prepare muffin, the cost of muffin has been increased.

Part V

Conclusion and recommendation

5.1 Conclusion

On the basis of research work, following conclusion have been drawn.

1. Optimization was done for 2 factors and 5 runs experimental plan for response surface analysis using Design-Expert® V 13.0.1.0
2. From sensory analysis, muffin with 12.5% date powder and 87.5 % sugar was found to be the best.
3. The nutritional quality of muffin seemed to be enhanced in case of fiber and total ash.
4. Incorporation of date powder cause reduction on loaf volume and specific loaf volume of product.
5. The chemical and microbiological analysis of product shows acceptability of muffin was up to seven days at room temperature without any artificial preservatives used
6. The cost of date powder substituted muffin was found somewhat more to control muffin.

5.2 Recommendation

1. Dates muffin can be commercialized by substituting sugar by date powder up to 12.5% of the total mixture.
2. Other varieties of dates can be used.
3. Date pits can be converted into powder and used as flour due to its high fiber content and other nutritional properties.

Part VI

Summary

Because of busy lifestyles, people are being drawn to quick snacks such as muffins, and cakes but junk food consumption leads to a variety of health problems such as obesity, malnutrition, and so on. In the current state of malnutrition practices and obesity, where people, primarily children, are affected by the prevalence of junk food, the development of a nutritious food is essential. People are also becoming concerned on eating healthy foods. On other side, during the post-harvesting process, 25-40% of dates are wasted. So, to solve both problems, we can turn dates into powder, which has a long shelf life, and use it instead of sugar in quick snacks. It will ensure proper utilization of the dates as well as preparation of healthy snacks for people. The present work is to find the limit up to where sugar can be replaced by date powder in whole wheat muffin. For this, dates were brought from Asan bazar of Kathmandu and converted into powder form whereas whole wheat flour, sugar, baking powder, butter, eggs were brought from local market of Dharan.

WWF containing 14.09 protein, 2.01 fiber, 1.2 fat, 2.02 ash content, 11.22 moisture and 69.46 carbohydrate was used and instead of sugar date powder with 2.4 protein, 5.5 fiber, 0.5 fat, 2.3 ash content, 15.9 moisture and 72.9 carbohydrate was used on percentage basis. Date powder and sugar were mixed in 5 different proportions A (100:0), B (87.5:12.5), C (75:25), D (62.5:37.5), E (50:50).Muffins were prepared by muffin method of mixing

Five major sensory characteristics i.e. color, appearance, flavor, texture, and overall acceptability were tested in the baked muffins. Sample A was control sample. Among all of the samples, Sample B was chosen as the best. All sensory qualities and physical measures reveal a significant difference in statistical analysis ($p<0.05$). In terms of physical parameters, these products were compared to the control. Only the best product was compared to the control sample chemically. All of the composites outperformed the control group in terms of fiber, ash. Physical evaluation of muffin samples revealed that the date powder substituted muffins had a lower loaf volume and specific loaf volume but a larger weight. The AV and PV of the best sample were studied for shelf life and found to increase with the number of days. The samples readings exceeds permitted value on the eighth day. As a result, by the eighth day, the muffin was no longer edible. The shelf of the product increased without adding any additives because of date present in it.

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Appendixes

Appendix A

Specimen card for sensory evaluation by hedonic rating test

Sensory evaluation of date powder substituted muffin

Name of panelist: Date:

Dear panelist,

Please test the given samples and score how much you prefer each one. Give points of your degree of preference of each parameter as shown below

Please rate the muffin from 1 to 9

Where,

9 = like extremely 4 = dislike slightly

8 = like very much 3 =dislike moderately

7 = like moderately 2 = dislike strongly

6 = like slightly 1 = dislike extremely

5 = average

Sample	Color	Texture	Flavor	Appearance	Overall
A					
B					
C					
D					
E					

Remarks:

_____

Signature

Appendix B

ANOVA table of sensory analysis of date powder substituted muffins

Table B.1: ANOVA (Two-way no blocking) at 5% level of significance for appearance

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.	Lsd
Muffin type	4	24.5200	6.1300	13.23	<.001	0.6174
Panelist name	9	17.5200	1.9467	4.2	<.001	0.8731
Residual	36	16.6800	0.4633			
Total	49	58.7200				

Connecting letters

Treatment	Mean	Significance
A	8.2	b
B	7.8	b
C	6.7	a
D	6.6	a
E	6.5	a

Table B.2: ANOVA (Two-way no blocking) at 5% level of significance for color

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.	Lsd
Muffin type	4	28.0000	7.0000	18.53	<.001	0.5575
Panelist name	9	22.4000	2.4889	6.59	<.001	0.7884
Residual	36	13.6000	0.3778			
Total	49	64.000				

Connecting letters

Treatment	Mean	
A	6.7	a
B	7.9	b
C	8.3	b
D	6.6	a
E	6.5	a

Table B.3: ANOVA (Two-way no blocking) at 5% level of significance for flavor

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.	Lsd
Muffin type	4	28.8800	7.2200	15.93	<.001	0.6107
Panelist name	9	20.1800	2.2422	4.95	<.001	0.8636
Residual	36	16.3200	0.4533			
Total	49	65.3800				
Connecting letters						
Treatment		Mean				
A		8		b		
B		8.2		b		
C		6.4		a		
D		6.6		a		
E		6.7		a		

Table B.4: ANOVA (Two-way no blocking) at 5% level of significance for texture

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.	Lsd
Muffin type	4	21.0800	5.2700	9.43	<.001	0.678
Panelist name	9	18.0800	2.0089	3.59	0.003	0.959
Residual	36	20.1200	0.5589			
Total	49	59.2800				
Connecting letters						
Treatment		Mean				
A		7.8		b		
B		8.0		b		
C		6.4		a		
D		6.7		a		
E		6.7		a		

Table B.5: ANOVA (Two-way no blocking) at 5% level of significance for overall acceptability

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.	Lsd
Muffin type	4	25.8800	6.4700	14.82	<.001	0.599
Panelist name	9	19.7800	2.1978	5.03	<.001	0.8476
Residual	36	15.7200	0.4367			
Total	49	61.3800				
Connecting letters						
Treatment		Mean				
A		7.9		b		
B		8.2		b		
C		6.5		a		
D		6.7		a		
E		6.6		a		

Appendix C

Table C.1 ANOVA (One-way no blocking) at 5% level of significance for volume

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.	lsd
Muffin type	4	895.68267	223.92067	3260.98	<.001	0.4767
Residual	10	0.68667	0.06867			
Total	14	896.36933				

Table C.2 ANOVA (One-way no blocking) at 5% level of significance for weight

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.	lsd
Muffin type	4	553.62933	138.40733	3992.52	<.001	0.3387
Residual	10	0.34667	0.03467			
Total	14	553.97600				

Table C.3 ANOVA (One-way no blocking) at 5% level of significance for sp. loaf volume

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.	Lsd
Muffin type	4	3.7588267	0.9397067	3523.90	<.001	0.02971
Residual	10	0.0026667	0.0002667			
Total	14	3.7614933				

Appendix D

Sample	Appearance	Color	Smell	Texture	Taste	Overall acceptability
A	8.2^{b}	6.7^{a}	8.0^{b}	7.8^{b}	7.8^{b}	7.9^{b}
B	7.8^{b}	7.9^{b}	8.2^{b}	8.0^{b}	8.1^{b}	8.2^{b}
C	6.7^{a}	8.3^{b}	6.4^{a}	6.4^{a}	6.6^{a}	6.5^{a}
D	6.6^{a}	6.6^{a}	6.6^{a}	6.7^{a}	6.7^{a}	6.7^{a}
E	6.5^{a}	6.5^{a}	6.7^{a}	6.7^{a}	6.6^{a}	6.6^{a}

Here, A = 0 parts date powder and 100 parts sugar muffin

B = 12.5 parts date powder and 87.5 part sugar muffin

C = 25parts date powder and 75 part sugar muffin

D = 37.5 parts date powder and 62.5 part sugar muffin

E = 50 parts date powder and 50 part sugar muffin

The figures represent the arithmetic mean of the scores in the table above. The figures in the same column with the same superscript do not differ significantly at the 5% level of significance. The product comprising 12.5 parts date powder and 87.5 parts sugar was rated as the best sample based on sensory evaluations conducted on aspects such as color, appearance, smell, taste, texture, and overall acceptability.

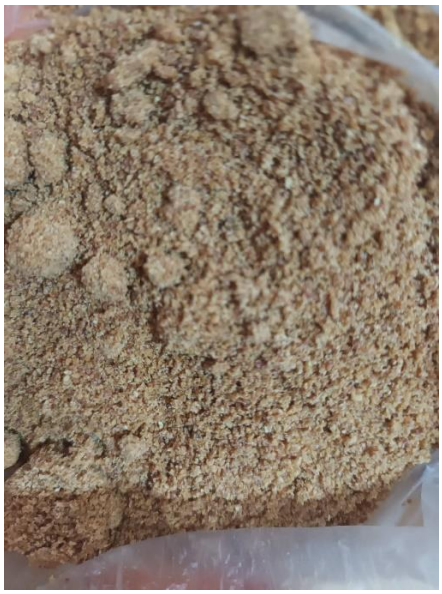
Appendix E

Cost evaluation of muffin

Ingredients	Rate	Amount	Cost (in Rs.)
Whole wheat Flour	90/kg	100 g	9
Date powder	980/kg	6.9 g	6.762
Sugar	80/kg	48.1 g	3.848
Butter	900/kg	55 g	49.5
Egg	15 piece	57 g	30
Baking Powder	45/100g	3 g	1.35
Milk	100/l	10 g	0.1
Raw material cost			100.56
Processing and labor cost(10% of raw material cost)			10.056
Profit (10%)			11.0616
Total cost (280 g)			121.6776
Total no of muffins formed		10	
Average weight of a muffin		29.97	
Total weight of muffin formed		299.7	
Total price (NRs/100g)			43.46

Appendix F

Plates



P.1 Raw Materials (Date powder)

P.2 Sensory evaluation

P.3 Optimized product in crates