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Development and standardization of muffins with the incorporation of pomegranate pomace

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Abstract
A granular apple also known as Pomegranate (*Punica granatum* L) is one of the highly grown fruit crops in sub-tropical and tropical regions where it is also one of the highly consumable fruits. After the extraction of juice, there is a leftover residue after filtration known as a solid mass or pomace it consists of seeds and arils also rich in several nutrient factors such as Anti-Oxidants, Anti-Microbial, High amounts of protein, fiber, and minerals such as calcium, etc. This pomace is generally used as a bio waste in several commercial sectors. The main aim of this project is to convert the bio waste into edible form through fortification and it has been successfully done by the incorporation of pomace into muffins a daily snack nutritional value is the resemblance of daily acceptable intake issued by WHO, as with the small amount (3%) of fortification it leads to a partial change in nutrient value and also induced cholesterol free food by adding plant-based butter (Fat), Egg Albumin (Egg White) as a base material.

Keywords: Fortification, Pomegranate Pomace, Supplementation, Cholesterol, Celiac Disease, Irritable Bowel Syndrome (IBS)

Introduction
Gluten is taken from the Latin word gluten (Glue), Which consists of storage proteins namely prolamins and glutelin, and are stored together with starch in various food materials such as Cereal (grass species) and are abundantly found in Wheat, Rice, Barley, Rye, Oat. Gluten consists of the elastic property and gives an elasticity nature to the dough, which resembles the Chewy and Puffy texture. Gluten comprises approximately 70-80% of the total volume of flour. (Akhondi *et al.*, 2019) [13]. Excessive consumption of gluten leads to a spectrum of health hazards namely Celiac Disease (CD) and Non-Celiac Gluten Sensitivity (NCGS). (Sapone *et al.*, 2012) [21]. Celiac Disease refers to Intestinal problems and acts on the Immune System and non-Celiac gluten sensitivity, which comprises irritable bowel syndrome (IBS). (Tanveer *et al.*, 2019) [9].

There is a chance of reducing Celiac Disease in the reduction of gluten content by the incorporation/fortification of gluten with other materials, such as Enriching Pomegranate / Potato Peel powder which increases water vapor permeability; Apple – Fresh Beef patties; Orange – Gelatin (Cup Cakes); Pine Apple peel powder – Probiotic Yogurt; Mango Peel Powder – Milk Supplementation; Dragon Fruit Peel – Agar (Kumar *et al.*, 2020) [8]. In this exponential work (Development of Muffins with pomegranate pomace powder), pomegranate pomace (Juice Waste) 22% of total waste is used as a fortifying agent as it consists of seeds and anile also having several nutritional factors such as a high number of polyphenols and fiber (Dietary Fiber) used as a food additive in Fiber Enriched products and small traces of calcium. (Alsubhi *et al.*, 2022) [1]. And consists of 45 types of fatty acids like Oleic Acid, Punicic Acid, Palmitic Acid, and Stearic Acid. Possess certain functions namely Anti Inflammatory, Anti-Oxidant, Anti-Microbial, and Anti-Diabetic.

Muffins are small, round, sweet breads and have been developed with the combination of different ingredients to the flour. Muffins are the word come from the French word "Mufflet", which generally originated from British and America. British Muffins: It is discovered by the Welsh in the 10th century. British muffins were commercialized in the 19th century in Victorionena, later they were coated in an English sentence "Here comes the Muffins Man". These muffins are Flat-shaped and Hollow inside.

Here the muffins were cooked in an especially round mold and those were placed on the Flame / Stove. America Muffins: These were developed in the 18th century and first used chemical-based yeast known as Pear lash which produces Carbon Dioxide when it is mixed with flour in addition to water to develop the dough. It has a concave surface like bulging (Raising) on the top and is filled inside without any hollow space. There are majorly 3 types/states of muffins that have been officially recognized by the U.S. namely Blue Berry Muffins, Massachusetts Swath Corn Muffins, and New York Apple Muffins.

Pomegranate (*Punica granatum* L) is derived from the Latin Malum Granatum, which means "Granular Apple" (Barnossi *et al.*, 2021) [23]. And is native to South Asia (India, China, Turkey, Spain, USA) and also can grow in tropical and subtropical areas (Barnossi *et al.*, 2021) [23]. The most popularly used variety in India is Ganesh (GB I) (Kushwaha *et al.*, 2020) [8]. Fruit is globose in shape of 6-12 cm in diameter. The pomegranate peel varies from Yellow / Green and Pink to dark purple and Intense Red (Holland *et al.*, 2009) [24]. Pomace resembles the solid remains of Fruits/Vegetables waste after Pressing/Extracting for Juice or Oil. Generally, it consists of Skin, Pulp, Seeds, Rind, etc. In pomegranates, the edible portion comprises 50% of the total weight and 50% corresponds to the peel. In turn, the edible portion is comprised of 78% Juice to the W/W and seeds weigh about 22%. There are different assorted products in the market such as Jellies, Jams, and Drinks. The Molecular weight of the pomegranate is between 500 and 3000 Da. According to Industry Oriented pomegranate juice waste is about 22%of the total waste. It consists of different components namely, Aril – 3%; Seed – 11%; Rind – 10%. The PH of pomegranate juice is about 3.1 and the Titratable acidity of pomegranate juice is 1.8.

Pomegranate consists of a high number of "Tannins". Pocess has a great therapeutic effect (Pocess defense against diseases and pathogenic microorganisms). The Bioactive components of pomegranate fruit and their transformation is done by the fermentation processes. (Gumienna *et al.*, 2015) [17]. Pomegranate consists of a high number of fatty acids about 45 types. Punicic Acid-76%, Palmitic Acid-3%, Stearic Acid-2%, Oleic Acid-5%, Others-7%. These fatty acids possess certain functions namely Anti Inflammatory, Anti-Oxidant, and Anti-Microbial. Anti-diabetic and very small amounts of pectin lead to the binding agents. The pomegranate seeds consist of polyphenols and mainly hydrolyzing tannins and anthocyanins, which are responsible for the bitter taste. And consists of a high number of polyphenols and fiber (Dietary Fiber) used as a food additive in Fiber Enriched products. (Alsubhi *et al.*, 2022) [1]. Moisture Content: 10.44-12.86%, Crude Protein: 6.71-8.11, Crude Ash: 1.61-2.9, Fiber: 17.33-27.84%. (Dadmohammadi *et al.*, 2021) [2].

Materials and Methods

Materials

The Raw materials such as Pomegranate, Refined wheat flour / All-purpose flour, Eggs (Whole/White), Pomegranate pomace, Sugar, Baking Powder, Flavor/ Essence, and the chemicals are used for the development and laboratory testing from the company Sigma-Aldrich.

The present study is conducted to develop. Development and standardization of muffins with the incorporation of pomegranate pomace with the various types of combinations were made at lab scale to figure out the best one in terms of both sensory and nutritional aspects. The details of the materials and methodology adapted are illustrated below. To perform the development of the muffins different trials have been performed and based on the sensory attribute and nutritional information one trial has been collected these trials include a Control Sample (CS) which resembles the pure form of a muffin without any addition of the other ingredients such as fortification material and it is mentioned in Table.1. Test Sample (TS) it includes in the processing of the preparation of muffins with the fortification material through to develop a fortified material here pomegranate pomace is used as a fortified material.

Table 1: Tabular column for the different measurements of Raw materials

Ingredients	Control Sample (CS)	Test Sample (TS)
Flour (Refined Wheat Flour)	100 g	97 g
Pomegranate Pomace powder	0 g	3 g
Egg (White)	60 g	60 g
Fat (Vegetable)	80 g	80 g
Sugar	80 g	80 g
Flavor	1ml (Pomegranate)	1ml (Vennila)

Preparation of Pomegranate Pomace Powder

Pomegranate pomace is generally obtained by the processing of the waste material obtained after the extraction of the pomegranate juice through mechanical juicers/ grinders. Where the pomegranate is collected the peel/rind of the pomegranate should be removed with the help of a hand (Mechanical Peeling) the color globular seeds also known as Arils should be collected and washed/ rinsed with water to remove some rind spoiled seeds which intern helps in the bitter flavor when peeling. The Arils and Seeds were then subjected to the mechanical grinders where the juice was extracted and filtered with the Sieve membranes of size 1-2 m (Conidi *et al.*, 2020) [4]. Collect the filtrate media and dry (Natural / Sun Drying) it for about 50 for 2 days (Mechanical Drying – Hot air Oven) and 38 for 4 days and then grind the residue with the help of mechanical grinders (Stone Grinders) to obtain a fine powder, the sieve size is about 150 m. Pack the powdered pomace into air-tight Aluminum Ziplock pouches. (Alsubhi *et al.*, 2022) [1].

Preparation of Muffins

Development of the muffins starts with the procurement of the raw materials at first the creaming should be done by mixing the Butter and Sugar in equal amounts by continuously mixing it with the whisker/agitator for about 10min, In the egg should be whisked until it forms into a soft lather consisting of foam and the required time for the process is 5min – 10 min, All-purpose flour / Maida is added with the combination of Pomegranate pomace and baking powder at the required compositions. Mix all the ingredients well until they form a slimy thick batter, Homogenize the batter for about 10 min, and place the batter into the waxed paper baking cups or molds. Preheat the oven to 180 / 10 min and bake it for 180 / 25 min, cool it to room temperature in the baking oven as it induces low moisture absorption through the surface of muffins. Pack it in a closed airtight container and store it in a cold place. (Jauharah *et al.*, 2014) [25].

Physical parameters

The weight (g) of the muffins was weighed by using a weighing balance. The height (cm) of the muffins was measured by using a ruler on three different sides. The volume () of muffins was determined by using the rapeseed displacement method with the 3 different samples. The density (g/) of the sample was calculated by dividing the weights (g) of the sample by the volume (g/). (AACC 2000 Method).

Proximate analysis

For Moisture (%) Weigh the sample about 5g with the help of a weighing balance and collect the weight of an empty Petri dish (7.52.5cm.). Now add the sample weight into a petri dish and place it in oven about 10510 in an electric hot air oven for about 4 hours take the sample out and weigh it. Moisture percentage by weight =. Ash (%) is calculated by weighing about 5g of the sample through weighing balance and collecting it into a porcelain crucible (ceramic base). The crucible is then transferred to a muffle furnace at 550 for about 5-6 hours until the grey ash has been obtained and weighed. Ash = [() 100] / W. Protein (%) was estimated by the Kjeld Hal method (AACC 2000 Method) No. 46-10. For fiber (%) sample was weighed about 3g, and the first digestion continued to digest the sample with 1.25% and 1.25% NaOH. Place it into a muffle furnace for about 3-5 hours at 550 or until the gray/white ash has been obtained. Crude fiber = 100 (ISO 1011 (2002): FAD 16). Fat (%) was calculated by weighing 5g of the sample and placing it into a thimble and defatting it with an organic solvent (petroleum ether/ethanol) in Soxhlet apparatus about 80 for 6-8 hours. Fat = [Loss in weight of the sample 100] Total weight of the sample. Carbohydrates (%) are estimated through a standard deviation formula which is formulated with the combination of the total percentile weight of the material and its moisture, ash, fat, and protein. Complete Carbohydrates = 100 – (M.C – Fat + Protein + Ash). (ISO 1011 (2002): FAD 16).

Shelf-Life Analysis

The shelf-life study of a developed food material (muffins) based on the incorporation of pomegranate pomace powder has been executed to the shelf-life analysis on the basic parameter through the appearance and palatability tests. As the muffins of both the control and test samples were placed in an incubator for some time with the optimum temperature and humidity control and they were completely desiccated at one place where there is low light and possessing no type of disturbance, the product should be checked daily whether it has been proclaimed that appearance and smell.

Sensory Evaluation

Sensory Evaluation should be done by a group of professionals known as panelists / Sensory Panel members who are certified to perform different organoleptic tests for different food materials. Based on the physical and textural formation of the material they will provide a rating based on the different parameters which is known as the Hedonic rating scale on a sensory card. On some following attributes such as Appearance; Taste; Texture; Flavor/Aroma and all acceptability. The ratings were included on a 9-point hedonic scale; 9-like Extremely, 8-like Very Much, 7-like Moderately, 6-like Slightly, 5-Neither like nor dislike, 4-dis like Slightly, 3-dis Like Moderately, 2-Dis like Very Much, 1-Dis like Extremely. **(**Jeong *et al.*, 2019) [11].

Result and Discussion

Physical Information

These testing parameters include weight, height, volume, and density of the Control Sample (CS) and Test Sample (TS) of Muffins and these parameters were possessed through the graphical representation below i.e., Fig.1, Fig.2, Fig 3 and Fig 4.

Table 2: Physical parameters of muffins

S. No	Physical Parameter	Result (CS)	Result (TS)
1.	Weight (g)	49.30±0.16	46.23±0.12
2.	Height (cm)	4.23±0.20	4.33±0.16
3.	Volume (ml)	71.30±0.24	73.36±0.20
4.	Density (g/cm^3)	0.690±0.00	0.630±0.00

Graphical Representation of Physical Parameters

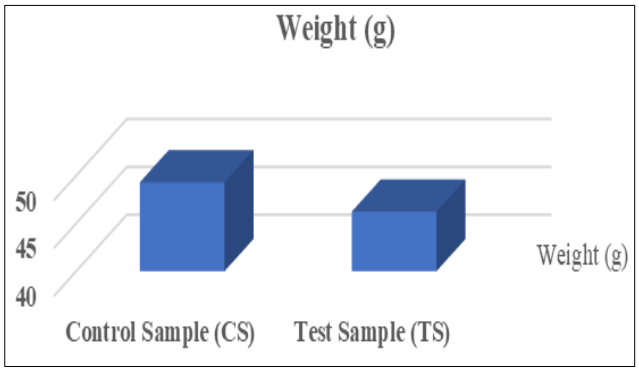


Fig 1: Graphical Representation of Weight (g), CS, and TS

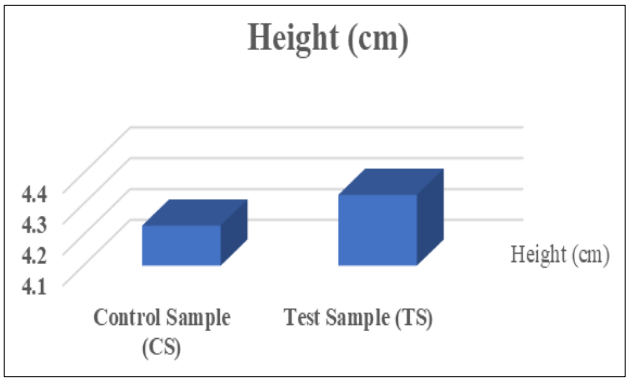


Fig 2: Graphical Representation of Height (cm), CS, and TS

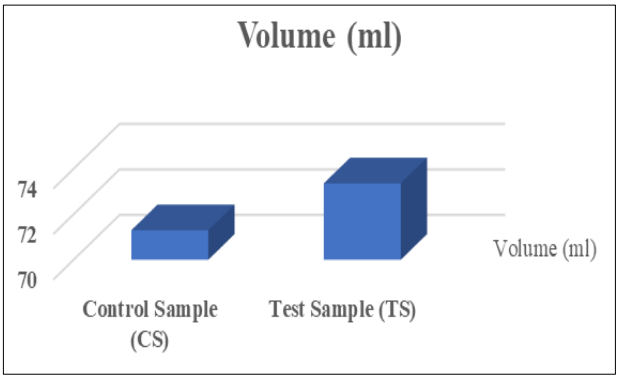


Fig 3: Graphical Representation of Volume (ml), CS, and TS

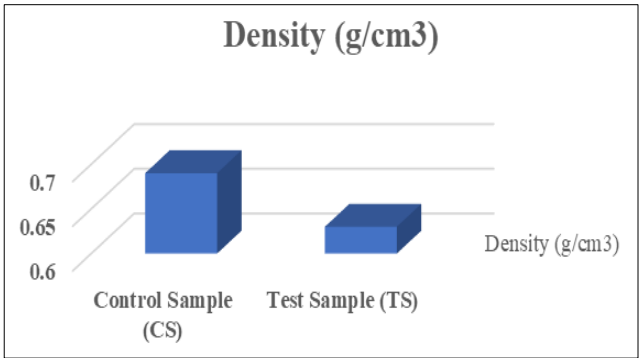


Fig 4: Graphical Representation of Density (g/cm3), CS and TS proximate analysis

These testing parameters included for Test Sample (TS) and Control Sample (CS) of Muffins are displayed below Table. 3 and also from the figures, Ash (Fig.5), Moisture Content (Fig 6), Fiber (Fig 7), Protein (Fig 8), Fat (Fig 9), Carbohydrate (Fig 10), Energy (Fig.11).

Table 3: Proximate Analysis chart for Control Sample and Test Sample

S. No	Testing Parameter	Result (Cs)	Result (TS)
1.	Ash (%)	1.33±0.12	1.13±0.12
2.	Moisture Content (%)	18.70±0.16	16.13±0.12
3.	Fiber (%)	0.07±0.01	0.13±0.01
4.	Protein (%)	6.10±0.02	6.40±0.01
5.	Fat (%)	29.13±0.12	21.09±0.01
6.	Carbohydrate (%)	56.84±0.03	57.40±0.01
7.	Energy (Kcal)	441.82±0.01	426.22±0.02

Proximate Analysis

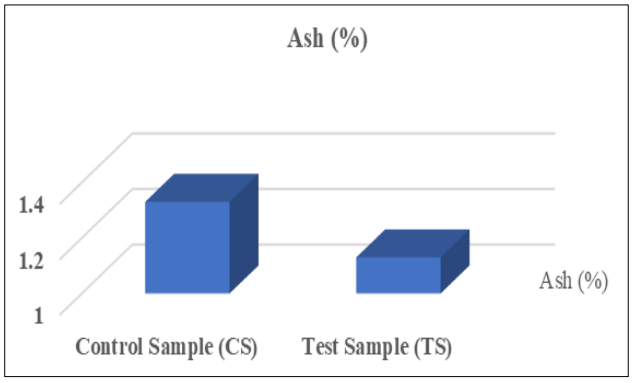


Fig 5: Graphical Representation of Ash (%), CS, and TS

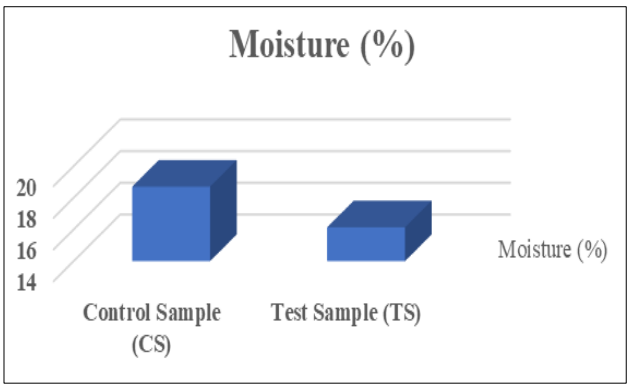


Fig 6: Graphical Representation of Moisture (%), CS, and TS

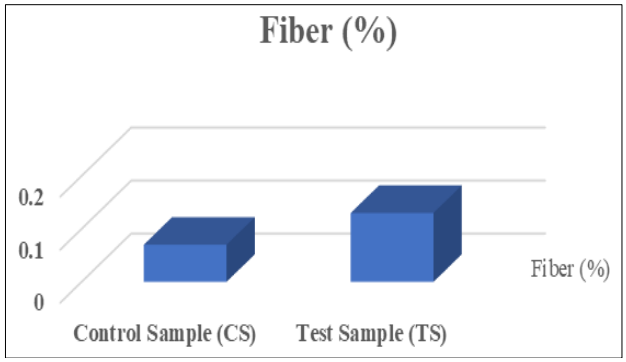


Fig 7: Graphical Representation of Fiber (%), CS, and TS

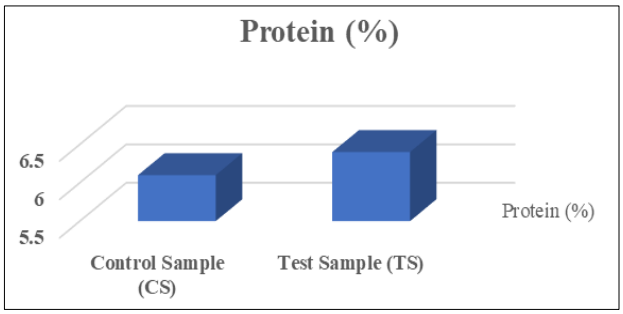


Fig 8: Graphical Representation of Protein (%), CS, and TS

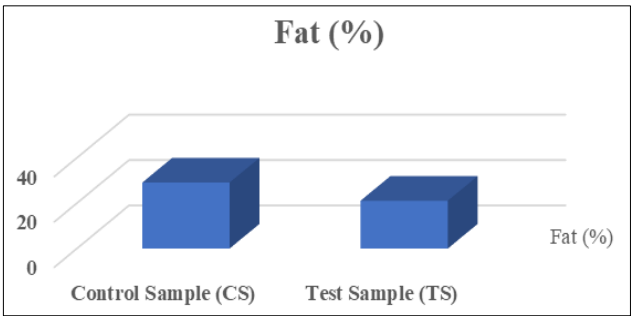


Fig 9: Graphical Representation of Fat (%), CS, and TS

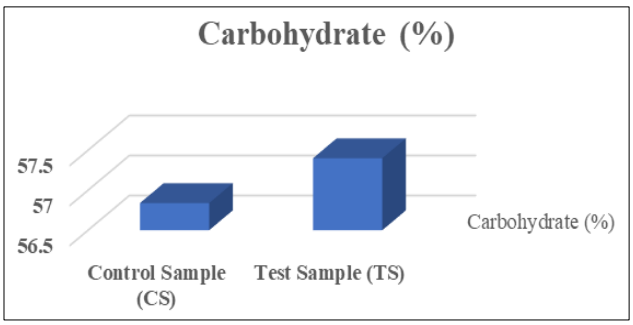


Fig 10: Graphical Representation of Carbohydrate (%), CS, and TS

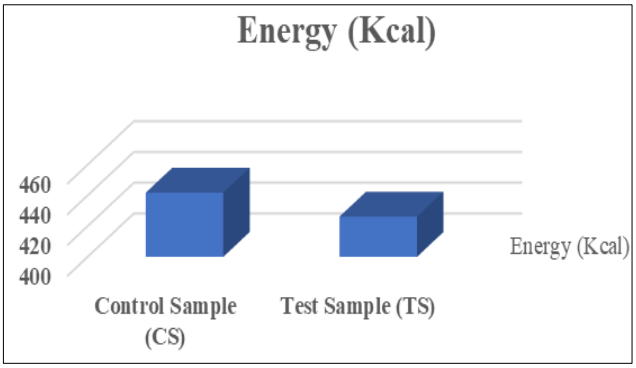


Fig 11: Graphical Representation of Energy (Kcal), CS, and TS

Shelf-life Studies

In this present experiment, the (CS) has gained 7 days of its shelf life and the (TS) possesses 10 days of its shelf life the major attribute to spoil the appearance and palatability things the heavy absorption of moisture from the air Fig.12, by muffins when compared to (CS) as it has the egg yolk which intern results in the off-flavor in very short time the (TS) Fig.13, absorbs low moisture content and results in the longer shelf life. The microbiological parameters are to be estimated.

Fig 12: Change in Appearance with moist surface

Fig 13: Off Flavor muffin

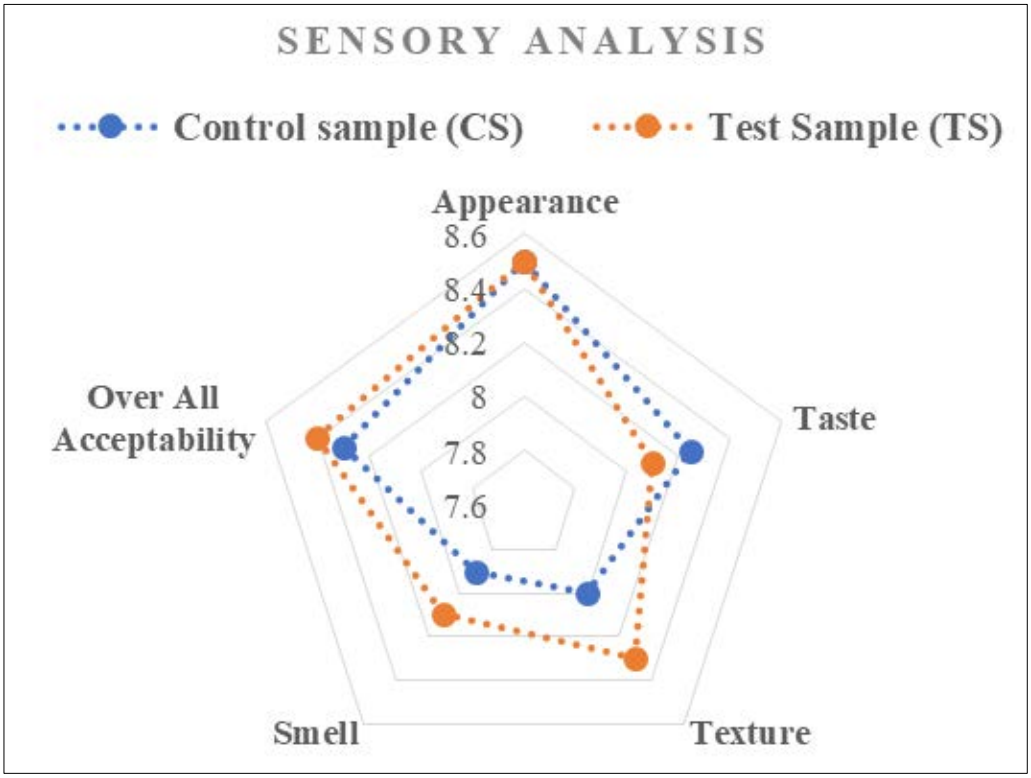
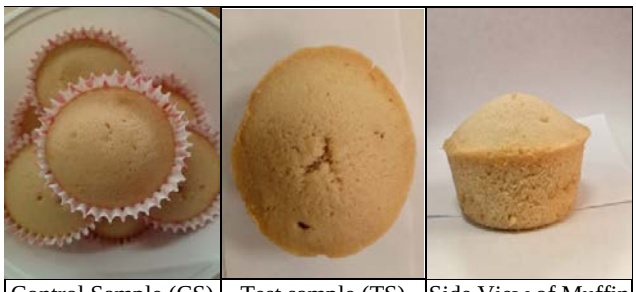


Fig 14: Sensory Analysis sheet of Control Sample (CS) and Test Sample (TS)



Control Sample (CS)	Test sample (TS)	Side View of Muffin

Fig 15: Complete development of Muffins (CS) and (TS)

Muffins that are developed by the incorporation of Pomegranate pomace (TS) have a high amount of protein content when compared to the (CS) as it is due to the only addition of egg white to the total volume of an egg taken and with the addition of pomegranate pomace. Fiber is compared to be a negligible increase in the amount of about 0.1% in (TS) when compared to (CS). Egg white has zero cholesterol which is responsible for the fat increase and butter that has been used for development is plant-based as the (TS) has a lower fat content of 19% and the whole egg consists of a certain amount of cholesterol as it impacts increase in the value of fat in (CS)-21.1. Total ash is based

on the amount of mineral content present in the food product. Moisture content in (CS)-1.5 is higher when compared to the (TS)-1.1 as the usage of sugar and the egg albumen leads to the height absorption of the moisture present in the atmosphere and the surface becomes moist and also leads to the gain of moisture content. The sensory evaluation of the developed product pomegranate pomace muffins (TS) results shows high acceptability in terms of Taste, Texture, Aroma, and overall acceptability when compared to the control sample (CS) without adding any type of fortifying materials and the complete sensory evaluation of 6 different panelists have shown in the graphical representation.

Conclusion

Muffins are one of the highly consumable bakery products as a snack, and the pomegranate pomace such as juice waste which consists of arils and seeds was generally dib rated as bio-waste after the extraction of juice. When we can consume complete fruit then there is a chance of wastage of nutritional components that can be easily acquired from the pomace. Hence, pomace is incorporated into muffins and it is determined through proximate analysis that the addition of pomace into muffins Processes nutritional benefits such as the increase in protein value, lethal increase in fiber content, lower fat content, and also some anti-microbial properties and thus with the fortification of pomegranate pomace about 3% to the total weight, all types of nutritional compositions were within the limits of Acceptable Daily Intake. The overall acceptability of the two different samples was mentioned and hence the test sample possesses major attention towards the organoleptic tests and has been highly preferential when compared to the control sample. There is a great chance of increase in the nutritional factor with the addition of the high amounts of pomegranate pomace and these are to be developed. Hence the initial stage at the minimal amount of incorporation of the pomegranate pomace has been successfully developed and tested.

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