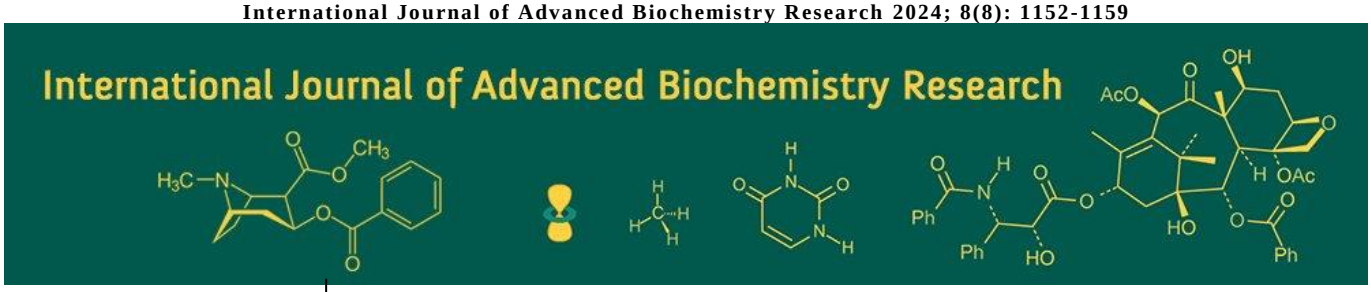

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Preparation of nutrient rich muffin blended with pomegranate peel powder, pumpkin seed flour and coconut powder

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Abstract
The present investigation entitled "Physico-chemical and sensory characteristics of nutrients rich muffins prepared from blends of pomegranate peel, pumpkin seed and coconut flour" was carried out in the Department of Food Science and Technology, Lovely Professional University, Phagwara, Punjab, India during 2023-2024. The experimental objectives were to standardize the recipe for Pomegranate peel powder, Coconut flour and Pumpkin seed flour-based muffins and to study the nutritional properties of prepared muffins. The experiment was laid out in a Completely Randomized Design (CRD) with four replications comprising of seven treatments *viz*., T_1: Wheat flour (control), T_2: [wheat flour(98%) + pomegranate peel powder (2%)], T3: [wheat flour (97%) + pumpkin seed flour(3%)], T_4: [wheat flour (96%) + coconut flour (4%)], T_5: [pomegranate peel powder (95%) + pumpkin seed flour (5%)], T_6: [pomegranate peel powder (94%) + coconut flour (6%)] and T_7: [pumpkin seed flour (97%) + coconut flour (3%)]. The dough prepared using wheat flour, pomegranate peel powder, pumpkin seed flour and coconut flour were baked at 150 °C for 15 minutes in oven. Among different treatments, significantly maximum acceptance during sensory analysis was recorded in T_2: [wheat flour (98%) + pomegranate peel powder (2%)].

Keywords: Muffins, fortification, wheat flour, pomegranate peel powder, pumpkin seed flour and coconut flour

Introduction
The pomegranate, or Punica granatum, is a member of the Punicaceae family. Iran is its primary centre of origin. Pomegranate and its chemical components have antioxidant, anti-inflammatory, anti-cancer, and anti- angiogenesis properties, among other pharmacological and toxicological properties. As a traditional treatment for acidosis, dysentery, microbial infections, diarrhea, helminth infection, haemorrhage, and respiratory ailments, the Pomegranate fruit has been extensively used. Colitis, colitis, menorrhagia, oxyuriasis, headache, diuretic, acne, piles, allergic dermatitis, and oral diseases can all be treated with the fruit juice and dried pericarp. The cultivation of pomegranate was introduced quite early in the eastern countries like India and India ranks first. Pomegranate area and production in between 2018- 19 was 253 ha and 2915 tonnes, and in between 2019- 20 was 264 ha and 2329 tonnes. Maharashtra (leading state), Karnataka, Gujarat, Andhra Pradesh and Tamil Nadu are major pomegranate producing states. Ganesh, Bhagwa, Ruby and Mridula are commercial cultivars. Pomegranate can also be divided into a number of anatomical parts, like the seed, juice, peel, leaf, flower, bark, and root.
Pumpkin seed powder also plays an important role in muffin making process. Pumpkin seed powder contained 6.9% moisture, 2.6% protein, 4.8% ash, 8.9% fibre, and 312.4 mg/100 g of total carotene. The incorporation of pumpkin seed powder into the muffin formulation changes the muffins and sensory quality. coconut, consumable product of the coconut palm (*Cocos nucifera*), a tree of the palm family (Aceraceae). In India area and production of coconut in between 2018-19 was 2151 ha and 14682 tonnes and in between year 2019-20 was 2154 ha and 14733 tonnes. Coconuts are one of the most important tropical crops and probably originated somewhere in Indo-Malaya. Each fruit needs a year to fully ripen, and a single coconut palm can produce 100 coconuts annually. The familiar single-seeded nut is surrounded by a thick fibrous husk on mature coconuts, which are ovoid or ellipsoid in

shape, 300-450 mm (12-18 inches) in length and 150-200 mm (6-8 inches) in diameter. One interesting fact about muffins is that there are two types of muffins:

British-style muffins and American- style muffins. Both types of muffins vary in terms of taste and history. British muffins have a flat shape and an empty inside. The Welsh made the discovery of British- style muffins in the tenth century. Muffin dough was cooked in a special ring-shaped mould that was placed directly on the stove or pan during the Middle Ages. Recipes for English muffins first appeared in the early 19th century. During the Victorian era, young men used special carts to sell muffins on the streets and rang bells to entice customers. During afternoon tea sessions, people will rush to purchase muffins and consume them. This practice inspired the English melody named and Here Comes the Muffin and More like bread cooked in a muffin pan, American muffins Because muffins are made of batter rather than dough, a muffin pan is required.

The batter was made with pear lash, a chemical yeast that produced carbon dioxide in the batter until the end of the 18th century. From that point on, the dough is made with baking powder (Pondan, 2019). . A muffin that does not crumble and is soft, spongy, and tender in the crumbs is what customers want. A muffin with the right texture, like hardness, cohesiveness, and a chewiness, and a stable batter that holds many tiny air bubbles are required. A lot of Maillard reaction products are created during muffin making, which involves baking in the oven. These compounds not only contribute to the flavour and texture of the food, but they also give it its colour.

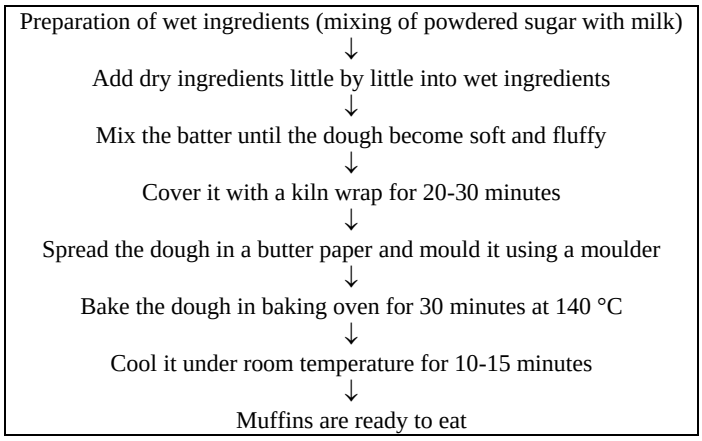
Materials

The pomegranate peel powder is prepared from pomegranate peel which were procured in the month of January from Phagwara local market. Pumpkin seeds were procured from the local market where raw and ripe varieties were available in Phagwara, Punjab. Coconut powder prepared from well ripened fresh coconut, which are dehusked, deshelled, paring removed and grated.

Methods

Laboratory methods and procedures used were adopted from (Tobaruela, *et al.,* 2018) [67]. Total soluble solids, Moisture content, titrable acidity, pH, total phenolic content, carbohydrates, ash content, crude fat, tannins, flavonoid content, antioxidant activity were estimated in the flours and the muffins.

Preparation of muffins using above mentioned ingredients



Flow Chart 1: Preparation of Muffins using above mentioned ingredients

Treatment details

The muffin's treatment combinations following the fortification of Pomegranate peel powder, Pumpkin seed flour, Coconut powder and wheat flour are shown in table 1

Table 1: The formulations of different blends prepared using wheat flour (WF), blended pomegranate peel powder (PPP), pumpkin seed flour (PSF)and coconut flour (CF) in varying ratios.

Code	Wheat flour (%)	Pomegranate peel powder (%)	Pumpkin seed flour (%)	Coconut flour (%)
T_1 (control)	100	0	0	0
T_2	80	20	0	0
T_3	80	0	20	0
T_4	80	0	0	20
T_5	80	10	10	0
T_6	80	10	0	10
T_7	80	0	10	10

Sensory analysis

Sensory evaluation of samples of pomegranate peel powder, pumpkin seed flour and coconut powder fortified muffins were carried out by a panel of 20 semi-trained judges. The panelist was given samples and asked to evaluate the samples for colour, texture, taste, aroma and overall acceptability by using 9- point hedonic scale (Annexure I) for each attribute in each product.

Results and Discussion

Table 2: Proximate composition of flours and powders used

Parameters	Pomegranate peel	Pumpkin seed	Coconut flour
Moisture (%)	0.22	4.37	6.48
Protein (%)	0.10	33.85	19.47
Fat (%)	0.1	24.83	36.77
Ash (%)	5.29	3.54	0.14
Fiber (%)	0.6	10.45	23.28
Carbohydrate (%)	3.81	59.77	63.26
Titratable acidity (%)	0.5	0.04	0.91
TSS(°Brix)	8.0	5.30	5.28
TSS/acid ratio	0.096	0.0864	0.04
Total sugar (%)	1.48	1.25	0.3
Reducing sugar (%)	6.56	0.21	0.11
Nonreducing sugar (%)	48.61	0.04	0.12
Water activity ($_{aw}$)	178.00	0.40	0.28
pH	0.2	6.21	6.37
Energy (Kcal)	321.09	426.7	604.44

The moisture content of Pomegranate peel powder is 0.22%, Pumpkin seed powder is 4.37% and Coconut flour is 6.48%. In terms of protein content, Pomegranate peel powder 0.10%, Pumpkin seed powder is 33.85% and Coconut flour is 19.47%.

Pumpkin seeds are recognized for their relatively high protein content, which is concentrated when processed into.

Table 3: Analysis of Anti - nutritional factors

Parameters	Pomegranate peel	Pumpkin seed	Coconut flour
Tannin	16.67 mg/g	1.94 mg/g	0.316 mg/g

Pomegranate peel includes a high concentration of tannins, notably ellagitannins. As a result, pomegranate peel powder is likely to contain a higher concentration of tannin than other dietary sources which is 16.67 mg/g. Pumpkin seed powder has lower tannin levels than pomegranate peel powder which is 1.94 mg/g. Coconut flour is formed from dried coconut flesh and normally contains low levels of tannins. As a result, coconut flour is anticipated to have less tannin than both pomegranate peel powder and pumpkin seed powder which is 0.316 mg/g.

Table 4: Analysis of Functional properties

Parameters	Pomegranate peel	Pumpkin seed	Coconut flour
TPC	224.61 mg	202.4 mg	30.36 mg
TFC	139.37 mg	39.2 mg	17.84 mg

Pomegranate peel powder, pumpkin seed powder, and coconut flour often have the greatest Total Phenolic Content (TPC). TPC in Pomegranate peel powder is 224. 61 mg. Pumpkin seed powder includes phenolic chemicals, albeit at lower amounts than pomegranate peel powder. While pumpkin seeds are recognized for their nutritional benefits and include antioxidants such as carotenoids and vitamin E, they typically have a lower TPC than pomegranate peel that is 202.4 mg. In contrast, coconut flour often has the lowest TPC of the three alternatives.

Pomegranate peel powder, pumpkin seed powder, and coconut flour often have the greatest Total Flavonoid Content (TFC). TFC content in Pomegranate peel is 139.37 mg. Pumpkin seed powder contains flavonoids, albeit at lower amounts than pomegranate peel powder. While pumpkin seeds are known for their nutritional benefits and include flavonoids such as catechins and flavanols, their TFC levels are typically lower than those of pomegranate peel that is 39.2 mg. Coconut flour had the lowest total flavonoid content of the three alternatives.

Table 5: Proximate Composition Analysis of Blends of Wheat Flour, pomegranate peel powder, pumpkin seed flour and coconut flour

Composition	Moisture (%)	Protein (%)	Fat (%)	Carbohydrates (g)
T_1	53.50^a	10.70^d	2.88^d	83.75^a
T_2	48.65^b	9.83^d	2.63^d	82.52^b
T_3	48.15^b	15.87^a	8.37^a	82.96^b
T_4	47.17^c	11.83^b	4.46^c	81.30^c
T_5	32.00^d	13.83^c	5.93^b	75.62^d
T_6	23.50^f	5.89^e	2.14^e	61.21^f
T_7	39.75^e	11.94^b	4.9^b	67.60^e
CD (0.05)	0.03	0.06	0.04	0.64

Shows the results of the proximate compositions of blend. The results obtained indicates that moisture content in differently treated combinations ranged from 23.5% to 53.5%. The highest values were observed for control sample i.e., 100% wheat flour (53.5%) and lowest is seen in T_6 sample i.e.,23.5%. The result confirms with the report of i.e., 53.5% for T_1 and T_6 23.5 by (Sharma *et al.*, 2016b) [68]. In terms of protein, the T_3 combinations shows the highest protein content i.e., 15.87% and the lowest protein content is seen in the T_5 combinations having 5.89%. A decrease in the protein content of T_6 compositions could be due to protein degradation. The fat content in the T_3 composition was found to be in the range of 8.37%. Highest fat content was observed for the same. powder form. Coconut flour generally has a modest protein content. While coconut flour may not provide as much protein as pumpkin seed powder, it is generally lower in comparison to other sources. Fat content of Pomegranate peel powder is 0.1%, Pumpkin seed powder is 24.83% and Coconut flour is 36.77%.

Pomegranate peels are typically low in fat and are commonly consumed for their antioxidant effects and dietary fibre rather than their fat level. Ash content of pomegranate peel powder is 5.29%. Pumpkin seed powder Ash content is 3.54. Ash content of coconut flour is 0.14%. Coconut flour is notable for its high fibre content with 23.28%. Pumpkin seeds have a significant dietary fibre content, however not as much as coconut flour that is 10.45%.

Pumpkin seed powder normally includes significant amounts of carbohydrate which is 59.77% While it is not as heavy in carbs as coconut flour, it does contribute to the carbohydrate content of dishes or recipes. Pomegranate peel powder typically has the lowest carbohydrate level of the three alternatives which is 3.81 Pomegranate peel powder may have a modest titratable acidity level which is 0.91. As a result, coconut flour is most likely the lowest in TSS of the three alternatives with 5.28 °brix.

As a result, pumpkin seed powder is likely to have a lower titratable acidity with 0.5% than other choices. Coconut flour is also not very acidic. coconut flour is expected to have a lower titratable acidity with 0.04% than pomegranate peel powder. In general, pomegranate peel powder may contain modest amounts of TSS with 8.0brix. So, pumpkin seed powder is anticipated to have less TSS than pomegranate peel powder with 5.30 °brix.

Coconut flour is made from dried coconut flesh, which contains less sugar and organic acids than fruits. As a result, the TSS/acid ratio in coconut flour is 0.04 most likely quite low when compared to pomegranate peel powder and maybe pumpkin seed powder. As a result, coconut flour most likely has a lower total sugar ratio than pomegranate peel powder and pumpkin seed powder which is 0.3%. In comparison to the other possibilities, pumpkin seed powder is likely to have a moderate total sugar ratio which is 1.25%. pomegranate peel powder may have a moderate to high reducing sugar content which is 6.56% depending on factors such as the ripeness of the fruit used and the processing method.

However, the water activity of coconut flour is often low enough to inhibit microbial development which is 0.28_{aw} Pomegranate is recognized for its somewhat acidic flavour due to the presence of organic acids such as citric acid and malic acid. So, the pH is 0.2. Pumpkin seeds are not particularly acidic, hence pumpkin seed powder is likely to have a pH near to neutral. While the pH might vary significantly depending on processing techniques, pumpkin seed powder is not normally considered acidic, unlike pomegranate peel powder. So, the pH is 6.2. Coconut flour typically has a neutral to slightly alkaline ph.

The energy is 604.44Kcal. Pumpkin seed powder may have a modest energy density which is 426.7Kcal. While pumpkin seeds include lipids and proteins, they are less calorie dense than coconut flour

Table 6: Proximate composition analysis

Composition	TSS (°Brix)	Titratable acidity (%)	pH	Energy (Kcal)
T_1	25.00^a	3.2^a	8.5^a	804.5^f
T_2	22.61^c	2.78^b	6.7^c	802.12^f
T_3	22.58^c	2.75^b	6.0^c	922.5^b
T_4	21.74^d	2.79^b	6.2^c	932^a
T_5	23.48^b	3.34^a	6.13^c	887.35^d
T_6	17.86^f	2.29^d	5.9^d	866^e
T_7	19.23^e	2.46^c	7.2^b	912^c
CD (0.05)	0.32	0.01	0.08	0.02

In the Compositions T_5 shows the highest measurement i.e., 3.34% and whereas T6 shows the lowest measurement i.e., 2.29%. Carbohydrates are a major source of energy and play a crucial role in the sensory characteristic of food products. According to the data obtained, the carbohydrate content is highest in T_1 sample having 83.75g followed by T_3, T_2, T_4. Lowest in T6 that is 61.21g followed by T_7 and T_5.

Table 7: Analysis of Antinutritional Properties: Tannin Content in Blend

Composition	Tannins (%)
T_1	0.64^f
T_2	0.98^e
T_3	1.04^e
T_4	1.15^d
T_5	1.22^c
T_6	1.30^b
T_7	1.44^a

As a result, adding pumpkin seed flour to the wheat flour muffin may somewhat raise the tannin level, but it will still be lower than in a muffin using pomegranate peel powder. Pomegranate peel powder combined with pumpkin seed flour and wheat flour muffin: Because pomegranate peel powder and pumpkin seed flour both contain tannins, this combination would have a greater tannin content than the basic wheat flour muffin. Pomegranate peel powder combined with coconut flour and wheat flour muffins: Similar to the last combination, this would have a greater tannin content than the simple wheat flour muffin due to the inclusion of pomegranate peel powder, but coconut flour does not provide significant tannins. A muffin made using pumpkin seed flour, coconut flour, and wheat flour would have a moderate tannin level. While pumpkin seed flour has some tannins, coconut flour usually does not.

Sensory evaluation of Muffins

Sensory evaluation of muffins was conducted to assess their overall quality, taste, texture, appearance, and aroma. A panel of trained evaluators participated in the analysis. The muffins were presented to the evaluators in a randomized and blind manner to avoid bias. During, the evaluation, the appearance of the muffins was visually examined, considering factors such as colour, shape, and surface texture. The muffins were then tasted, and the evaluators assessed their flavour, sweetness, and any specific taste attributes. Sensory evaluation of gluten-free millet-based muffins was carried out on 9-point hedonic scale and the results are given in table.

Table 8: Sensory evaluation of blends of pomegranate peel, pumpkin seed flour and coconut flour-based Muffins

Composition	Colour and appearance	Texture	Taste and aroma	Mouthfeel	Overall acceptability
T_1	7.85^c	7.85^b	7.57^d	7.80^c	7.77^e
T_2	7.62^e	7.76^c	7.63^c	7.75^d	7.53^f
T_3	7.93^b	7.83^b	7.88^b	8.09^b	7.92^c
T_4	7.78^d	7.72^c	7.55^d	7.69^e	7.86^d
T_5	8.30^a	8.27^a	8.55^a	8.36^a	8.52^a
T_6	7.98^b	7.86^b	7.92^b	8.03^b	8.06^b
T_7	7.74^d	7.64^d	7.60^c	7.74^d	7.81^d

The given data represents the results of a sensory evaluation of muffins with different compositions, denoted as T_1 to T_7, based on colour and appearance, texture taste and aroma, mouthfeel, and overall acceptability. Overall, the muffins received favourable scores in all sensory attributes, with average ratings ranging from 7.53 to 8.52 on a scale of 1 to 10. The colour and appearance of the muffins were rated between 7.62 and 8.30, indicating that the muffins had a visually appealing presentation.

Physical characteristics of muffins

Physical and textural properties affect consumer acceptance. Physical changes during baking include water evaporation, volume expansion, development of a porous structure, and alternations in dimensions of muffins. It is seen before that weight of muffins remained more or less similar to that of control sample.

Table 9: Physical characteristics of muffins

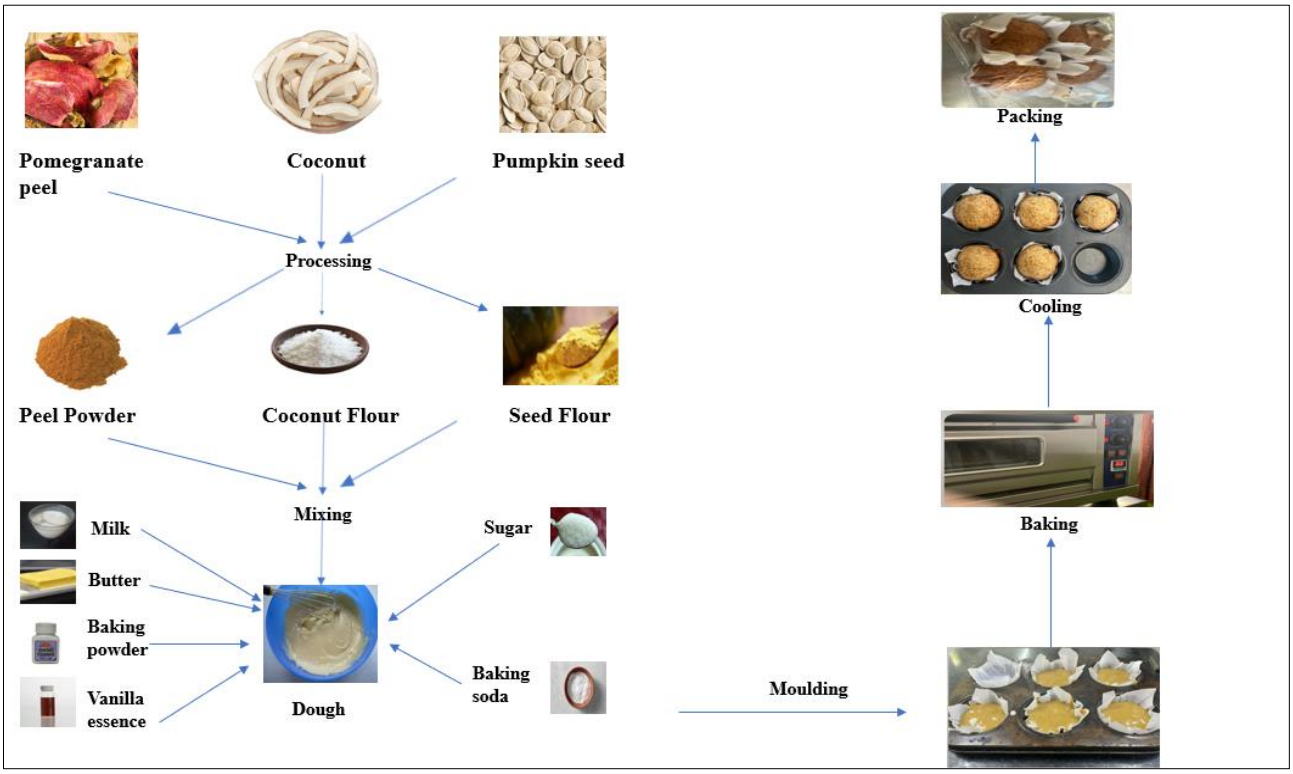
Composition	Weight	Diameter	Thickness	Density	Volume	Spread ratio
T_1	7.50^{c}	4.08^{b}	3.36^{d}	0.21^{b}	31.23^{a}	2.07^{c}
T_2	7.55^{b}	4.04^{c}	3.30^{d}	0.20^{c}	31.21^{c}	2.02^{f}
T_3	7.45^{d}	4.08^{b}	3.60^{a}	0.19^{d}	31.19^{e}	2.07^{c}
T_4	7.57^{b}	4.01^{d}	3.43^{c}	0.21^{b}	31.22^{b}	2.67^{a}
T_5	7.59^{a}	4.12^{a}	3.63^{a}	0.23^{a}	31.22^{b}	2.09^{b}
T_6	7.42^{d}	4.08^{b}	3.56^{b}	0.19^{d}	31.20^{d}	2.06^{d}
T_7	7.52^{c}	3.99^{f}	3.56^{b}	0.21^{b}	31.20^{d}	2.03^{e}

Looking at the weight and diameter values, it can be observed that there are slight variations between different compositions. The weight ranges from 7.42 to 7.59, while the diameter ranges from 3.99 to 4.12. The highest weight is associated with T_5, while the smallest weight is recorded for T_6. On the other hand, the largest diameter is found in T_5, while the smallest diameter is found in T_7. However, the differences in weight and diameter among the compositions are relatively small, as evidenced by the narrow range of standard deviations. The thickness and density also show some variation across the compositions. T_5 has the highest thickness value of 3.63, while T_2 has the lowest thickness value of 3.30. Similarly, T_1 has the highest density value of 0.21, and T_3 has the lowest density value of 0.19. It is worth noting that the standard deviations for these parameters are generally smaller, suggesting a more consistent measurement.

Table 10: Determination of Textural analysis

Composition	Hardness (kg)	Fracture ability (mm)
T_1	8.309^{b}	0.94^{b}
T_2	5.293^{e}	0.77^{c}
T_3	5.547^{d}	1.13^{a}
T_4	9.637^{a}	0.97^{b}
T_5	2.448^{f}	0.34^{e}
T_6	6.410^{c}	0.51^{d}
T_7	4.945^{e}	0.53^{d}

In table the effects of blends of pomegranate peel powder, pumpkin seed flour and coconut flour addition on textural properties of muffins in terms of hardness is given. It could be observed that hardness of muffins with addition above flours with wheat flour. The control sample prepared with only wheat flour T_1 had hardness 8.309 N of 100% wheat flour. The sample T_4 reported value of 9.637 N which was higher than control sample. The sample T_2, T_3, T_6 and T_7 had hardness values of 5.293 N, 5.547 N, 6.410 N, 4.945 N respectively. The lowest hardness is found in sample T_5 that increasing trend of hardness as compared to control may be due to decreasing moisture content.



Graph 1: Preparation of nutrient rich Muffin blended with pomegranate peel powder, pumpkin seed flour and coconut powder

Conclusion

Muffins are adaptable baked products that provide a satisfying blend of flavour, texture, and convenience. Muffins have a particular place in many people's hearts, whether they're eaten as a quick breakfast on the run, a soothing snack, or a sweet treat with a cup of coffee.

These components provide a varied spectrum of nutrients. Pomegranate peel powder includes antioxidants and fibre; wheat flour contains carbs and some protein; coconut flour contains healthy fats and fibre; and pumpkin seed flour contains protein, healthy fats, and minerals such as magnesium and zinc. Wheat flour may cause problems for people with gluten sensitivity or celiac disease, thus alternative flours like as coconut and pumpkin seed can give gluten-free solutions. However, in order to avoid cross-contamination, these substances must be pure. Depending on the proportions, the muffins may have a distinct look, with specks of colour from the pomegranate peel powder and a slightly thicker texture from the coconut and pumpkin seed flours. Finally, the conclusion would most likely take into account the muffins' overall flavour, texture, and nutritional value. They offer a nutritious, tasty snack that enhances overall well-being and meets diverse dietary needs. T_2: having wheat flour (80%) & Pomegranate peel powder (20%) is recommended by our study as it is nutrient rich and has great sensory characteristics.

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