Formulation, standardization and sensory evaluation of multigrain mathri

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Abstract- **This study focuses on the formulation and evaluation of Multigrain Mathri, a fiber-rich snack incorporating multigrain and spices. The objective was to develop a nutritious and consumer-acceptable snack using various grain flours, including sorghum, rice, pearl millet, dried green peas, oats, and gram flour. The physical and chemical properties of the product were analyzed. The best-accepted sample, Sample D, exhibited good sensory attributes, including a crunchy texture and enhanced taste, primarily due to the inclusion of whole wheat flour and rice flour. The final product had 11.62% protein, 9.13% fat, 54.44% carbohydrates, 10.42% fiber, and 3.64% ash content, indicating its nutritional richness. This positions the Multigrain Mathri as a cost-effective and viable snack alternative. The study concludes that Multigrain Mathri is a healthy, fiber-rich snack suitable for vegetarians and vegans. Its nutritional benefits, ease of preparation, and lack of preservatives make it a promising ready-to-cook snack option. Further research is suggested to explore alternative cooking methods like baking and improve storage stability.**

Keywords- Fibre rich snack, Multigrain, Mathri, Nutrition

INTRODUCTION

In recent years, there has been interest in the creation of multigrain flour and related products because of its distinctive flavors, textures, health advantages, and nutritional value. Multigrain flour has been demonstrated in studies to improve the nutritional profile and boost the nutritional value of people with a variety of chronic illnesses. Combining two or more flours not only improves their nutritional value but also fills in the nutrient deficiencies of the other flour. Different multigrain flour products had varying nutritional contents: protein ranging from 5.85 to 18.45%, carbs from 40.97 to 88.97%, fat from 1.08 to 37.56%, fiber from 1.30 to 22.55%, iron from 1.64 to 86.1%, and calcium from 0.46 to 56.09%. Therefore, compared to single grain flour products, multigrain flour and its derivatives are higher in nutrients and offer more health advantages. Research on multigrain Indian food products and its assessment of their nutritional value and acceptability was scarce. In order to control the incidence of lifestyle diseases like obesity, diabetes mellitus, cardiovascular disease, and various types of cancer, research on indigenous Indian recipes that can be prepared and used at the household level must be done. The expanding multigrain flour market demonstrates that the Indian populace is increasingly returning to healthier lifestyle choices, and the demand for multigrain goods is only expected to increase, spurring additional developments in this area [1].

The pearl millet grains were finely ground after the samples were collected, and their composition in six minerals (Na+, K+Mg2+, Fe2+, Zn2+, and Ca2+) was determined. The proximate (ash, dry matter, protein, starch, and total and reducing sugars) and causal factors were identified using standard analytical AOAC techniques. The association between these variables was then assessed using the Pearson association Analysis (PCA). Protein, total, and reducing sugar levels varied significantly, according to our data (ranging from 1.86 to 93.4 mg/g, 178.64 to 652.54 mg/g, and 16.62 to 174.22 mg/g, respectively). Additionally, a highly significant association ($P<0.001$) between the quantities of starch and amylose was found. The levels of minerals also varied greatly; for example, some cultivars of millet were especially enriched in iron and magnesium (the ranges being 13.85 to 2766.31 mg/kg and 340.27 to 4769.9 mg/kg, respectively). Based on information from the PCA, four groups of pearl millet can be identified: iron-rich millets [2].

Chickpeas *(Cicerarietinum L.)* are a major pulse crop that is grown and consumed worldwide, especially in Afro-Asian countries. It is a good source of both protein and carbs and is thought to contain higher-quality protein than other pulses. Chickpeas provide significant levels of all the essential amino acids. Dietary fiber comes in second to starch as the primary storage carbohydrate. Chickpeas have a low fat content but are an excellent source of oleic and linoleic acid, two important unsaturated fatty acids. Chickpeas are rich in proteins and carbohydrates, which account for around 80% of the dry seed mass. According to some research, the starch content of different chickpea cultivars varies between 41% and 50%. The kabuli variant has higher soluble sugars. The crude protein content of chickpeas ranges from 12.4% to 31.5%. For consumers on a vegetarian diet with limited resources, the 6% fat level of chickpeas is important. The fiber constituents of the Kabuli and Desi types differ in both quantity and quality. The protein is believed to be of higher quality than other pulses. Chickpeas contain significant levels of each. Ca, Mg, P, and most importantly K are also present in chickpea seeds. Chickpeas are a good source of important vitamins, such as riboflavin, niacin, thiamine, folate, and β-carotene, the precursor to vitamin A. Chickpea seeds, like other pulses, have anti-nutritional components that can be reduced or eliminated by cooking them in different ways. They may be able to lower the risk of a number of serious diseases that affect people, such as Type 2 diabetes, cardiovascular disease, intestinal issues, and some types of cancer, when paired with other pulses and grains. Chickpeas include important minerals for nutrition, particularly calcium and iron, where good availability of iron has been described. Immature green chickpea seeds have been shown to have 2.2 mg of thiamine (100 g)-1 and 0.7 mg of riboflavin (100 g) [3].

In particular, it contains high concentrations of a variety of phenolic compounds that are possibly rare in other cereal grai ns.The bran layer of sorghum grain contains the majority of the phenolic compounds; the content, concentration, and extractability of phenolic compounds vary greatly throughout sorghum genotypes and variations. Sorghum mutagenesis variant RED for GREEN has been found to significantly increase the amounts of 3-deoxyanthocyanidins, condensed tannins, and overall phenolic contents in sorghum leaves [4].

In temperate regions, oats (*Avena sativa L.*) are a well-known annual crop. It is acknowledged as a nutritious food that has substantial levels of fat-soluble vitamin E, β-glucans, soluble dietetic fiber, and polyunsaturated fatty acids worldwide. The content of fat, protein, and vitamin E (α-tocopherol) as well as the makeup of fatty acids, dietary fiber, and amino acids were measured in the samples under study. The obtained data revealed that the fat content varied widely amongst varieties. Alpha-tocopherol remains a significant antioxidant component in crude oats even after the lipid is refined. Additionally, distinct fatty acids (FA) have various effects on human health. Numerous research projects quantify the health benefits of monounsaturated (MUFA) and polyunsaturated (PUFA) fatty acids. Eating more dietary fibre has the potential to improve nutrition and overall health. Research has demonstrated that dietary fibers can help prevent heart disease, diabetes, certain types of cancer, and enhance short- and long-term memory. The World Health Organization (WHO) suggests consuming at least 25 grams of dietary fiber daily. In the USA and Europe, the average intake is only 12–18 g, whereas in Africa, it is 40–60 g. Obesity is one effect of this imbalance in dietary fiber intake. have discussed the dietetic value and suitability of oat grains for the production of functional foods more frequently in scientific literature. Because of their high nutritional content, oats are a common ingredient in baby foods. The need for oats will rise in tandem with the expansion of feed lots and the creation of better oat varieties in terms of feed value [5].

More than one-third of the world's population depends on wheat as their primary stable food crop, and it provides more calories and protein to the global diet than any other cereal crop. It can be processed into a variety of foods and is nutrient-dense, convenient to transport, and store. With their essential coating of bran, vitamins, and minerals, wheat is still regarded as a good source of protein, minerals, B-group vitamins, and dietary fiber. Wheat is also an excellent food for promoting health. Wheat flour is used to make vital wheat gluten, or seitan, as well as bread, biscuits, candies, and noodles. There are several health advantages to wheat. Its gluten and starch give it energy and warmth. Phosphates and other mineral salts are coated in its outer bran, an indigestible part that facilitates easy bowel movements. Vitamins B and E can be found in wheat germ. Muscle growth and repair are facilitated by wheat protein. The bran and wheat germ found in whole wheat provide protection against conditions such as diabetes, heart disease, diverticulum, appendicitis, constipation, and intestinal diseases. Enhancing the quality and amount of proteins and carbohydrates, as well as the amount of vitamins, vital amino acids, minerals, and other beneficial elements of wheat, requires an understanding of the molecular and genetic regulation of many aspects of plant growth and development [6].

Dough's rheological characteristics are a crucial building block in the process of producing high-quality goods. The two primary methods for determining the properties of flour dough are empirical and fundamental. The farinograph, Falling Number apparatus, rapid visco analyser, etc., as well as multifunctional new apparatus like Mixolab, can be used for conducting empirical measurements. The purpose of the study was to use Mixolab to assess the rheological characteristics of dough made from various cereal flours and flour blends. In this study, whole grains such as triticale, rye, hull-less barley, rice, maize, and flour blends were utilized. Triticale was used to make flour blends by combining it in different amounts with other flours [7].

Because of its flavor, color, and pungency, chili *(Capsicum spp.)* is used as a spice in almost every cuisine. Along with other vitamins, minerals, calcium, magnesium, folate, potassium, thiamin, iron, copper, and other vitamins A, B6, and K, chili is a great source of vitamin C. Capsaicin, the main bioactive component of chili, is responsible for the spice's potent flavor and several health benefits. Capsaicin is used in pharmaceuticals for its analgesic, anti-inflammatory, anti-bacterial, anti-arthritic, and anti-rhinitis properties. Manganese and iron are both abundant in cumin. Tryptophan is the limiting amino acid among the eighteen amino acids found in cumin seeds, which are considered essential amino acids. Cumin has a variety of uses in traditional medicine, such as addressing diarrhea, jaundice, dyspepsia, and hoarseness. The seeds exhibit stomachic, diuretic, carminative, stimulant, astringent, and abortifacient properties. They also have numerous physiological effects on the immune, neurological, reproductive, and gastrointestinal systems; additionally, cumin is known to be: Hypoglycemic, Hypolipidemic, and an excellent source of iron. Sesame is known for its health-promoting properties and is high in proteins, carbs, antioxidants, lignans, tocopherols, and other micronutrients. This enigmatic crop has anti-immunoregulation, anti-oxidant, anti-hypersensitivity, and anti-cancer properties. Sesame seeds come in a wide variety of varieties and are found in many agro-ecological zones worldwide. India is one of the major producers, and they are seen to be thriving everywhere. The oil from this seed can be extracted using straightforward solvent extraction and expelling techniques. As an alternative, with the advancement of technology, supercritical extraction can also be employed. A very beneficial drug, sesame has the natural capacity to treat a wide range of illnesses [8].

2. MATERIALS

The present project work entitled "Formulation and standardization of Multigrain Mathri'' was carried out in laboratory of Department of Food Technology, Yashavantrao Chavan Institute of Science Satara.

2.1. Ingredients:

The all required materials like rice flour, pearl millet flour, gram flour, sorghum flour, dried green peas flour, oats flour, whole wheat flour, salt, and spices like red chilli powder, cumin seeds, sesame seeds, ajwain, kasuri methi, turmeric and oil were collected from the local market.

2.2. Formulation of Multigrain Mathri

The Multigrain Mathri was prepared through a sequence of standardized processing steps. Selected flours, sorghum, rice, pearl millet, oats, wheat, dried green peas, and gram flour along with spices were cleaned and sorted to ensure purity. The grains were dry-roasted for 5 minutes [9] to reduce moisture and enhance flavor, then ground using a commercial mill and sieved through a 64-mesh to ensure fine particle size. Cumin (*Cuminum cyminum*) and ajwain (*Trachyspermum ammi L.*) were also dry-roasted and coarsely ground.

All dry ingredients were mixed thoroughly, followed by the addition of spices based on decreasing particle size. Hot oil and warm water were added sequentially, and the mixture was kneaded into a uniform dough. The dough was rolled into sheets (2.5–3.0 mm thick), cut into circular shapes, and deep-fried in rice bran oil at 125 °C for 3 minutes[10]. After cooling, the snacks were packed in airtight, food-grade packaging to preserve quality.

Fig. 1
Selection of Raw Material

Fig. 2 **Fig. 3**
Weighing of raw material (Flours and Spices)

Fig. 4
Dry Mixing

Fig. 5
Addition of hot oil

Fig. 6
Mixing

Fig. 7
Dough preparation

Fig. 8
Moulding

Fig. 9
Frying

Fig. 10 Pictorial presentation of Final Product- Multigrain Mathri

2.3 Treatment Details:

For the formulation of the Multigrain Mathri, total four trials were taken as sample A, sample B, Sample C, and Sample D. The same procedure was followed for all four trials and the composition were followed as shown in table 1

Table 1: Composition of Multigrain Mathri

Sr. No	Ingredient	Sample A (%)	Sample B (%)	Sample C (%)	Sample D (%)
1	Rice flour	17.40%	7.95%	8.14%	24.83%
2	Pearl millet flour	17.40%	27.82%	24.43%	16.55%
3	Gram flour	17.40%	7.95%	16.28%	2.69%
4	Sorghum flour	17.40%	7.95%	8.14%	8.27%
5	Dried peas flour	17.40%	7.95%	8.14%	8.27%
6	Oats flour	17.40%	7.95%	4.07%	4.13%
7	Whole Wheat flour	0%	0%	0%	4.13%
8	Spices and salt	10.37%	10.16%	10.41%	10.58
9	Oil	2.61%	2.38%	2.44%	2.48%

2.4 Proximate Analysis:

The estimation of the food sample's ash, moisture, fat, and protein contents is part of this analysis.

1) Moisture content: After the 5 g sample was ground up and dried for 5 hours at 105°C in an oven, its moisture content was measured by weighing it. It was weighed once more after being chilled in desiccators until it reached a consistent weight. The weight loss as a result was calculated using the moisture content [11].

2) Fat Content: Using a Soxhlet device, five grams of crushed product were carefully weighed in a thimble and defatted with petroleum ether. The lipid content was then ascertained by evaporating the ether extract [11].

3) Crude Fibre Content: Initially, 2 to 5 g of a moisture and fat-free sample were digested using 200 ml of boiling 0.255 N H_2SO_4. To keep the volume constant, water was added to the mixture at regular intervals while it boiled for 30 minutes. At the conclusion of this period, the mixture was filtered through filter paper, and the residue was rinsed with hot water until it was free of acid. Following the sample's transfer, 200 ml of boiling 0.313 N NaOH solution was added to the same beaker. After 30 minutes of boiling, the mixture was filtered through filter paper. Hot water was used to rinse the residue until no alkali remained. After being moved to a crucible and allowed to dry overnight at 80–1000 degrees Celsius, it was weighed. After four hours of heating at 550–6000C in a muffle furnace, the crucible was cooled and weighed once more. The difference between the weights indicated the weight of the crude fiber [12].

4) Ash Content: A silica crucible containing five grams of product was weighed, burned, and cooled over a brief flash until the solid was completely burned. After cooling in the desiccator, the sample spent four hours at 550°C in a muffle furnace. After cooling in the muffle furnace, it was weighed once more, and the process was repeated until two measurements were identical. The percent ash was calculated using the difference between the initial and final weights [11].

5) Protein Content: The Micro-Kjeldhal technique, which entailed digesting 200 mg of material in concentrated sulfuric acid with 1 g of catalyst combination for two to three hours at 100°C, was used to measure the protein content. Following a 40% NaOH distillation, the ammonia that was released was captured in 4% boric acid and titrated against 0.01N H_2SO_4 using a mixed indicator method (Methyl red: Bromocrysol green 1:5). The percentage of protein in the sample was then estimated using a factor of 6.25, and the proportion of nitrogen was then calculated using a method [11].

6) Carbohydrate Content: The carbohydrate content was determined using the difference technique [12].

2.5. Sensory Assessment:

The scientific method for eliciting, quantifying, evaluating, and interpreting reactions as perceived by the senses of sight, smell, touch, taste, and hearing is sensory assessment. Semi-trained panel members, who were academic staff members of the Yashavantarao Chavan Institute of Science, Satara, were asked to rate the overall products on a 9-point hedonic scale with descriptive words ranging from 1 (strongly dislike) to 9 (very like). They were evaluated for sensory qualities such as appearance, color, taste, flavor, and texture [13].

Table 2: 9-Point Hedonic Scale

Sr. No.	Remarks	Score
1	Like extremely	9
2	Like very much	8
3	Like moderately	7
4	Like slightly	6
5	Neither like not dislike	5
6	Dislike slightly	4
7	Dislike moderately	3
8	Dislike very much	2
9	Dislike extremely	1

3. RESULTS

Present investigation on was carried out in the Department of Food Technology, Yashavantrao Chavan Institute of Science, Satara. The mathri was formulated by taking total three trials A, B, C and D from which the Trial D was selected by the 9-point hedonic scale by the faculty members and students form the Department of Food Technology.

Chemical properties of Multigrain Mathri were studied by analysing moisture content, fat, protein, fibre, ash, carbohydrates and the results are shown in the table 3. Various tests are taken for that and all the equipment and chemicals are handled with care.

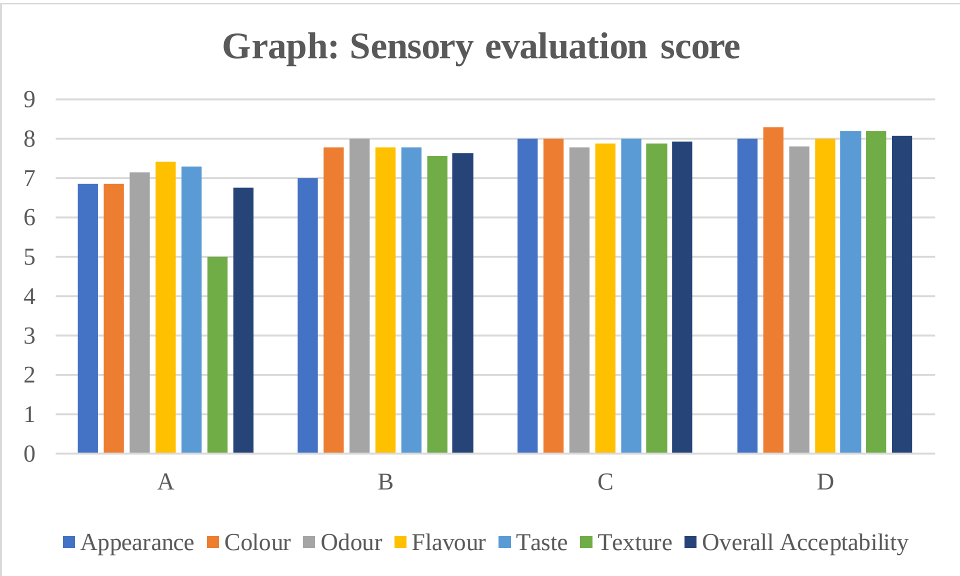
Table 3: Results of proximate analysis

Sr. No	Test Done	Sample A
1	Moisture	10.75%%
2	Fat	0.33%
3	Protein	11.62%
4	Fibre	10.42%
5	Ash	3.64%
6	Carbohydrates	63.24%

A 9-point hedonic rating scale was used for sensory evaluation of Multigrain Mathri. It was evaluated for different attributes based on a 9-point hedonic scale was used for colour, flavour, texture, taste, mouthfeel and overall acceptability. The product was evaluated by panel members [13].

Table 4: Sensory evaluation score

Sample	Appearance	Colour	Odour	Flavour	Taste	Texture	Overall Acceptability
A	6.85	6.85	7.14	7.42	7.28	5	6.75
B	7	7.77	8	7.77	7.77	7.55	7.64
C	8	8	7.77	7.88	8	7.88	7.92
D	8	8.3	7.8	8	8.2	8.2	8.08



Graph 1: Sensory evaluation score

4. CONCLUSION

On the basic of Sensory analysis, it is possible to prepare multigrain mathri with various cereals flours as a source of nutrients. It is rich in fiber. Therefore, it is an innovative as well as nutritious product gifted to the market it was concluded the Sample D was found accepted during sensory evaluation.

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6. REFERENCES:

[1] Vishwakarma, Neha & Phadnis, Meenal. (2023). Development of cereal and millet based multigrain chips using variety of mixes. *International Journal of Home Science*. 9. 288-290. 10.22271/23957476.2023.v9.i2e.1501.

[2] Adéoti, K., Kouhoundé, S. H. S., Noumavo, P. A., Baba-Moussa, F., & Toukourou, F. (2017). Nutritional value and physicochemical composition of pearl millet (*Pennisetum glaucum*) produced in Benin. *Journal of Microbiology, Biotechnology and Food Sciences*, *7*(1), 92–96.

[3] Hirdyani, H. (2014). Nutritional composition of Chickpea (*Cicerarietinum-L*) and value added products - a review. *Indian Journal of Community Health, 26*, 102-106

[4] Xiong, Y., Zhang, P., Warner, R. D., & Fang, Z. (2019). Sorghum Grain: From Genotype, Nutrition, and Phenolic Profile to Its Health Benefits and Food Applications. *Comprehensive reviews in food science and food safety*, *18*(6), 2025–2046.

[5] Šterna, V., Zute, S.A., & Brunava, L. (2016). Oat Grain Composition and its Nutrition Benefice. *Agriculture and Agricultural Science Procedia, 8*, 252-256

[6] Kumar, P., Yadava, R. K., Gollen, B., Kumar, S., Verma, R. K., & Yadav, S. (2011). Nutritional contents and medicinal properties of wheat: A review. *Life Sciences and Medicine Research*, *2011*(22), 1–10

[7] Sabovics, M., Straumīte, E., & Galoburda, R. (2011). Assessment of the rheological properties of flour using the Mixolab. In *Proceedings of the Food BALT 2011 Conference* (pp. 33–38). Latvia University of Agriculture

[8] Yamuangmorn, S., Sreethong, T., Saenchai, C., Rerkasem, B., & Prom-u-thai, C. T. (2021). Effects of roasting conditions on anthocyanin, total phenolic content, and antioxidant capacity in pigmented and non-pigmented rice varieties. *International Food Research Journal*, *28*(1), 73–82

[9] Ranganathan, V., Nunjundiah, I.T., & Bhattacharya, S. (2014). Effect of roasting on rheological and functional properties of sorghum flour. *Food Science and Technology International, 20*, 579 – 589

[10] Pushparaj, F. S., & Urooj, A. (2017). Impact of household processing methods on the nutritional characteristics of pearl millet (*Pennisetum typhoideum*): A review. *MOJ Food Processing & Technology, 4*(1), 28–32

[11]https://fssai.gov.in/upload/uploadfiles/files/Manual%20of%20methods%20on%20Cereal%20and%20Cereal%20Products.pdf

[12] Cvrk, Ramzija & Junuzović, Halid & Smajić-Bećić, Arnela & Kusur, Amela & Brčina, Tijana. (2022). Determination of Crude Fiber Content and Total Sugars in Correlation with the Production Process and Storage Time. *International Journal for Research in Applied Sciences and Biotechnology*. 9. 1-6. 10.31033.

[13]Sukanya Wichchukit, Michael O'Mahony, The 9-point hedonic and unstructured line hedonic scales: An alternative analysis with more relevant effect sizes for preference, Volume 99, 2022

[14] Wood, J. A., & Grusak, M. A. (2007). Nutritional value of chickpea. In S. S. Yadav, R. J. Redden, W. Chen, & B. Sharma (Eds.), *Chickpea breeding and management* (pp. 101–142). CAB International.

[15] Debnath, S., Bhat, K.K., & Rastogi, N.K. (2003). Effect of pre-drying on kinetics of moisture loss and oil uptake during deep fat frying of chickpea flour-based snack food. *Lwt - Food Science and Technology, 36*, 91-98

[16] Jalgaonkar, K., Jha, S. K., & Sharma, D. K. (2016). Effect of thermal treatments on the storage life of pearl millet (*Pennisetum glaucum*) flour. *The Indian Journal of Agricultural Sciences*, *86*(6), 762–767

[17] Gwekwe, B. N., Chopera, P., Matsungo, T. M., Chidewe, C., Mukanganyama, S., Nyakudya, E., Mtambanengwe, F., Mapfumo, P., & Nyanga, L. K. K. (2024). Effect of dehulling, fermentation, and roasting on the nutrient and anti-nutrient content of sorghum and pearl millet flour. *International Journal on Food, Agriculture and Natural Resources, 5*(1), 1–7

[18] Kaveh, M., Abbaspour-Gilandeh, Y., Fatemi, H., & Chen, G. (2021). Impact of different drying methods on the drying time, energy, and quality of green peas. *Journal of Food Processing and Preservation, 45*, Article e15503

[19] Gu, Y., Qian, X., Sun, B., Tian, X., Wang, X., & Ma, S. (2022). Effect of roasting treatment on the micromorphology, gelatinization, structure, and digestibility of whole oat flour. *LWT – Food Science and Technology, 162*, Article 113828

[20] Rizki, H., Kzaiber, F., Elharfi, M., Ennahli, S., & Hanine, H. (2015). Effects of roasting temperature and time on the physicochemical properties of sesame *(Sesamum indicum .L)* seeds. *International Journal of Innovation and Applied Studies, 11*, 148-155

[21] Mn, N.P., Kr, S., Deepika, S., Prasad, Vijay, N., Kothari, R., & NanjundaSwamy, S. (2012). A Review on Nutritional and Nutraceutical Properties of Sesame. *Journal of Nutrition and Food Sciences*, *2*, 1-6.

[22] Singh, H., & Meghwal, M. (2019). Ajwain a potential source of phytochemical for better health. *The Pharma Innovation Journal, 8*, 599-603.

[23] Debnath, S., Rastogi, N.K., Krishna, A.G., & Lokesh, B.R. (2012). Effect of frying cycles on physical, chemical and heat transfer quality of rice bran oil during deep-fat frying of poori: An Indian traditional fried food. *Food and Bioproducts Processing*, *90*, 249-256.