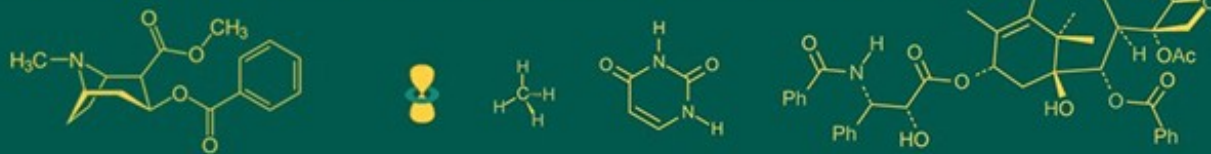


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Standardization of process technology for Mathri sticks from tender jackfruit flour and whole wheat flour

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ABSTRACT

The snack industry has been widely growing due to consumer demand for tasty and nutritious food. Mathri sticks is popularly Rajasthan traditional food which is deep fried snack. Mathri stick was developed by flour composition of Tender Jackfruit flour and Whole Wheat flour as C₁ (10:90), C₂ (16:84), C₃ (22:78), C₄ (28:72), C₅ (34:66), and using various frying temperature T₁- 130 °C, T₂-140 °C, T₃-150 °C Tender Jackfruit flour : Whole Wheat flour i.e. (22%:78%) and frying temperature at 150 °C was the best treatment. Mathri sticks prepared from Tender Jackfruit flour and whole wheat flour 22% :78%, and frying temperature at 150 °C had the properties as the best treatment. The properties at the best treatment had moisture 4.282 ± 0.036 (%), Protein 7.606 (%), Ash 3.321 ± 0.048 (%), Fat 33.481 ± 0.428 (%), Fibre 3.102 ± 0.014 (%), Energy 536.993 ± 2.260 (kcal), Carbohydrate 51.320 ± 0.423 (%). Colour (L, a, b), (34.106 ± 0.458, 3.363 ± 0.060, 17.320 ± 0.010) Hardness 145.000 ± 1.687 N was found to be best. The Mathri prepared with best treatment i.e. (22%:78%) had highest sensory attribute i.e. Colour (8.480 ± 0.268), Flavor (8.220 ± 0.192), Taste (8.300 ± 0.158), Texture (8.300 ± 0.874), Overall acceptability (8.440 ± 0.15).

Keywords: Mathri sticks, Frying temperature, Deep fat frying, Tender Jackfruit flour, Whole Wheat flour and frying temperature

1. Introduction

Mathri sticks, also known as mathiya or mathari, is a traditional deep-fried savoury snack that originated in Rajasthan, India. It is prepared using wheat flour, water, and ajwain, resulting in a crispy, flaky and mildly salty cracker. Commonly served with tea or accompanied by pickle, Mathri is a popular snack during tea time. It was traditionally developed as a long shelf-life food that could remain suitable for consumption for several days without refrigeration. After preparation, it is usually stored in airtight containers at room temperature, making it a convenient and preferred snack for travel due to its extended storage stability. It is a deep-fried snack primarily prepared using refined wheat flour (*Maida*), which contributes to its high carbohydrate and fat content while offering limited nutritional value. Owing to the increasing consumer demand for healthier and nutritionally enriched snack products, considerable efforts have been made to modify the conventional formulation of Mathri sticks by incorporating nutrient-dense ingredients without adversely affecting its sensory quality.

Traditionally, the product is prepared by kneading refined wheat flour with water and other ingredients to form a dough, shaping it into discs or square pieces, and deep-frying until a crisp, golden-brown texture is achieved (Wadmare *et al.*, 2025) [1].

Deep-fat frying, or immersion frying, is the traditional method used to make popular foods like French fries, potato chips, donuts, and fish sticks. This complex process relies on exceptionally high temperatures, these extreme temperatures trigger significant, permanent changes to the microscopic structure of the food and is also responsible for some distinct characteristics like flavor, taste, color, texture and crust formation (Ouchon *et al.*, 2003) [2]. Deep-fat frying is a unit operation which is performed by immersing the food material in hot (generally between 150 and 200 °C) edible oil until it is cooked (Farkas *et al.*, 1996) [3]. It is a complex process in which simultaneous heat and mass transfer occurs between the frying oil and the food material (Asokapandian *et al.*, 2020) [4]. During frying, heat is transferred from the hot oil to the product, while moisture migrates from the food to the surrounding oil, resulting in a counter-current flow. This process is characterized by heat transfer, moisture evaporation, mass transfer, and oil absorption, all of which significantly influence the texture, quality, and overall characteristics of the fried product (Vitrac *et al.*, 2002) [5].

The colour of the food surface are the first quality parameter evaluated by consumers and are critical in the acceptance of the product, even before entering in the mouth. The colour appearance is dependent on the amount and distribution of brown regions developed during frying as well as the oil absorbed on the surface

after frying, which produces oily areas with transparent appearance (Marquez *et al.*, 1986) [6]. The golden-brown color of fried foods is primarily attributed to non-enzymatic browning reactions, such as Maillard and caramelization reactions, which also contribute to the unique flavors of fried products (Chang *et al.*, 2020) [7].

Jackfruit (*Artocarpus heterophyllus* Lam.) is an under-utilized tropical fruit abundantly cultivated in India, particularly in the Konkan region and Western Ghats. Tender Jackfruit flour (TJF) obtained through convective hot air drying is rich in dietary fiber, minerals, and vitamins, and exhibits desirable functional properties suitable for incorporation into fried snack products. Whole wheat flour (WWF), being rich in fiber, B-vitamins, iron, and zinc etc. and other complements i.e. Tender Jackfruit flour is developing a nutritionally enriched composite snack. Development of *Mathri* sticks from Tender Jackfruit flour and Whole Wheat flour thus presents an opportunity to create a health-oriented product suitable for all age groups. Therefore, the present study was undertaken to evaluate Tender Jackfruit flour incorporated at different level with Whole Wheat Flour and frying temperature, on *Mathri* stick formulations, and standardized it and study its nutritional and textural properties.

2. Materials and methods

2.1. Materials

The present research work entitled “Development of *Mathri* sticks from Tender Jackfruit flour and Whole Wheat Flour” was carried out in laboratory of Department Post Harvest Engineering, Post Graduate Institute of Post Harvest Management, Killa -Roha Dist. Raigad, Maharashtra.

2.2. Ingredients

The all required material like Tender Jackfruit flour, whole wheat flour, semolina and spices like red chilli, turmeric, ajwain, oil, and salt, were collected from the local market of Kolad village.

2.3. Formulation of *Mathri* sticks

Mathri sticks was prepared by combining different proportions of Tender Jackfruit flour and Whole Wheat Flour. Hot ghee was poured into the mixture, followed by the addition of Ajwain, Chilli, Turmeric and Salt. All ingredients were mixed well. Water was added to make semi-hard dough, which was then divided into small balls. The thin sheet was folded and cut uniformly into stick-shaped pieces of approximately 5-6 cm in length and 1-1.5 cm in width. The stick shaped *Mathri* sticks were deep fat fried in sunflower oil at 130°C, 140°C, 150°C temperatures until golden brown and crispy coloured the product was obtained. *Mathri* sticks: oil ratio was 1:40 to make properly puffed, and well- developed flaky layers and crisp texture and main-

tain the temperature of an electric fryer. The deep fat fried *Mathri* sticks were drained on absorbent paper to remove excess oil, cooled to room temperature and subjected to quality evaluation. The process flowchart for preparation of *Mathri* sticks incorporated with Tender Jackfruit flour (TJF) and Whole Wheat flour (WWF) is presented in Fig.1.

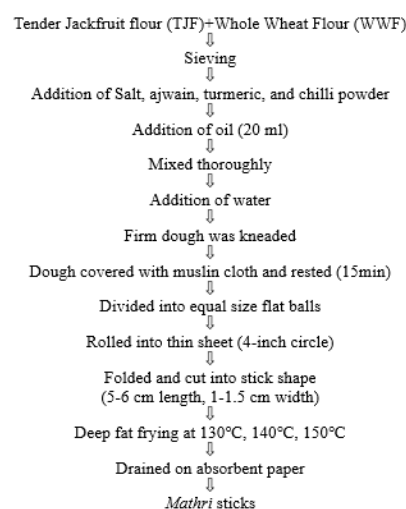


Figure 1. Process flowchart for *Mathri* sticks prepared with incorporated of Tender Jackfruit flour with Whole Wheat flour

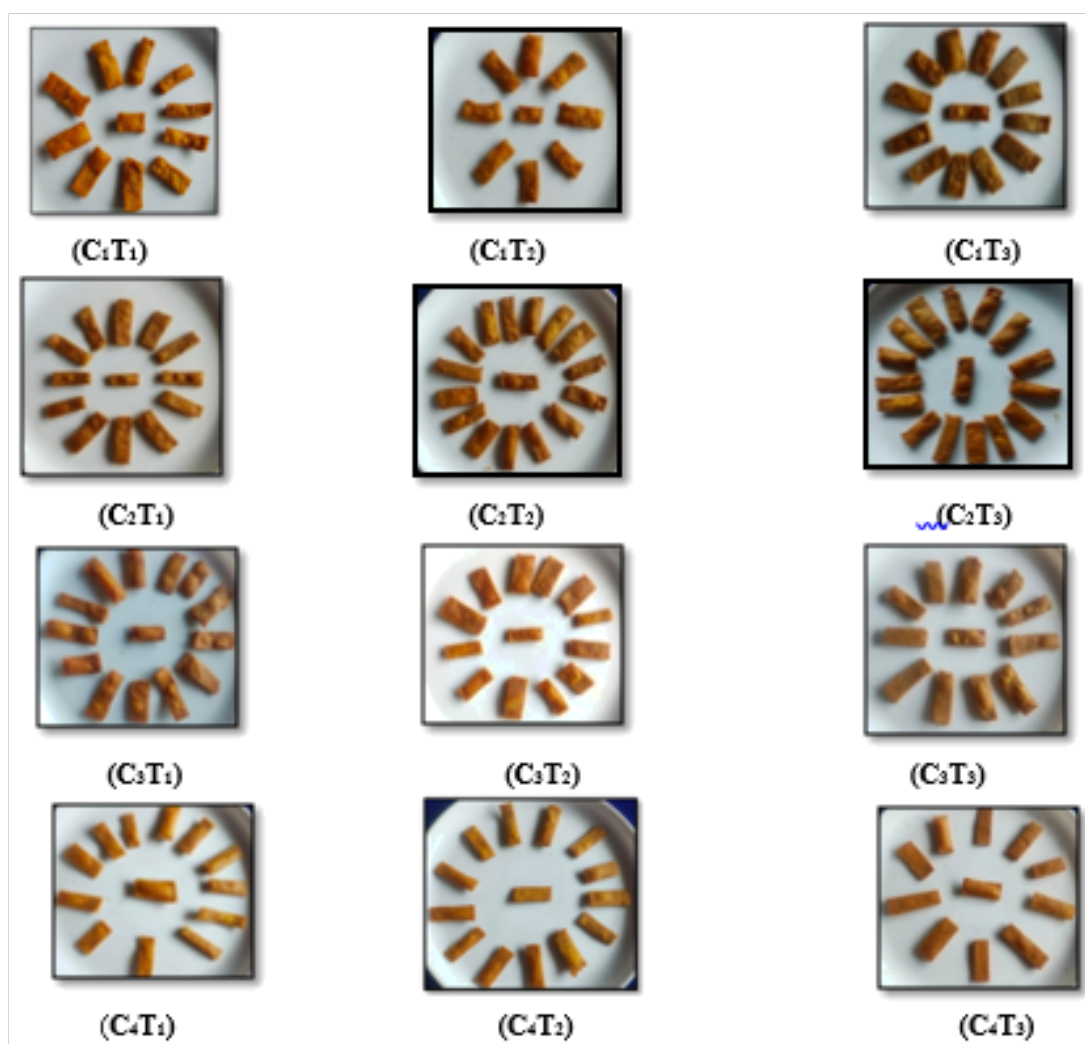
3. Treatment details

For formulation of the Tender Jackfruit flour based *Mathri* sticks comprises 5 treatments (C₁, C₂, C₃, C₄, C₅) were taken and one control sample (C₆) were taken as show in Table.1. , Fig.2. shows the photograph of *Mathri* sticks prepared from various concentrations of the Tender Jackfruit flour (TJF) of varied level (10%, 16%, 22%, 28%, 34%) and Whole Wheat flour (WWF) varied level (90%, 84%,78%,72%,66%) were mixed together as per the treatment combination in Table.1. The mixture was added semolina(40g), Salt (5g), Ajwain(1g), Chilli(5g), Turmeric(1g), Ghee(20g), Water(100 ml) were used as per treatment combination and it was added for proper mixing and kneading of dough. The *Mathri* were deep fat fried for 130°C, 140°C, 150°C temperature.

Table 1. Composition of *Mathri* sticks

Treatment	Tender Jackfruit flour	Whole Wheat Flour
C ₁	10	90
C ₂	16	84
C ₃	22	78
C ₄	28	72
C ₅	34	66
C ₆	-	100

(continued on next page)



C₆ (Control Sample

T₂ = 140°C, T₃ = 150°C).

3.1 Frying time (minutes)

The ideal frying temperature and time was chosen based on colour during frying process through the physical observation of the product. The ideal frying condition determines on until golden brown colour appeared as per the procedure (Mundhe *et al.*, 2022) [8].

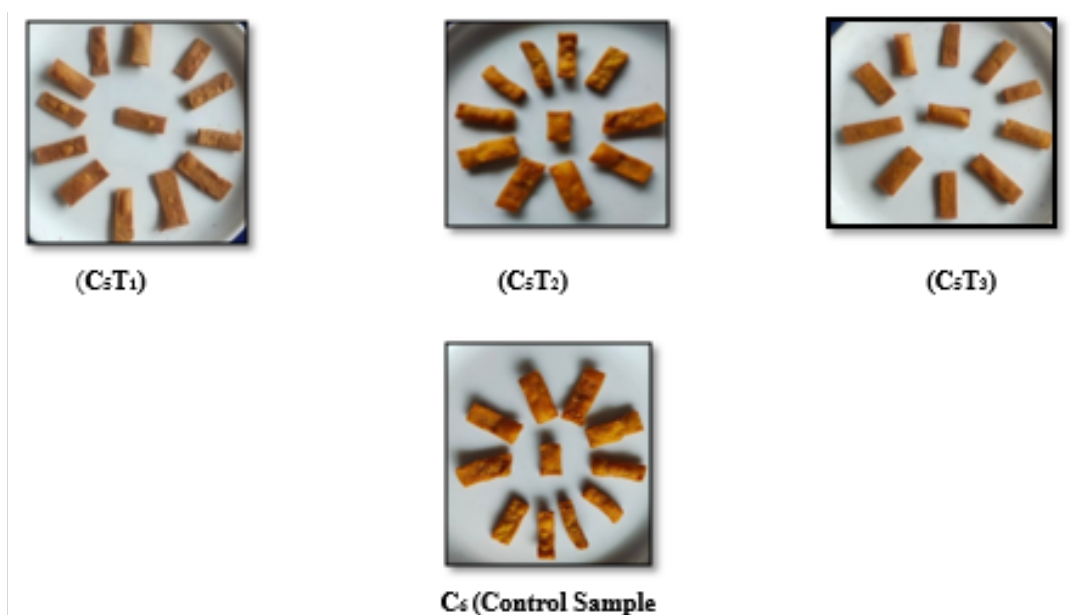


Figure 2. Tender Jackfruit flour based *Mathri* in various concentration and different frying temperature, (C₁ = 10% Tender Jackfruit flour, C₂ = 16% Tender Jackfruit flour, C₃ = 22% Tender Jackfruit flour, C₄ = 28% Tender Jackfruit flour, C₅ = 34% Tender Jackfruit flour) T₁ = 130°C,

3.2 Moisture (% db.)

The Initial moisture content of *Mathri* sticks sample prepared by Tender Jackfruit flour of treatment composition (C₁-C₅) and frying temperature (T₁-T₃) determined by (AOAC 2000). 5 g sample was weighed and dried in a hot air oven (Make M/s: Aditi Associate, Mumbai. Model: ALO-136) at 105±1°C for 5 hrs. Its moisture content was measured by weighing it before and after drying. It was weighed again after being cooled in a desiccator until it reached a constant weight. The weight loss was calculated as a moisture content using this following formula Eq (1) Each observation was recorded three times to get the replication.

$$\text{Moisture Content (\% db.)} = \frac{W_1 - W_2}{W_1} \times 100 \quad (1)$$

Where,

W₁ = Initial weight of sample before drying, g

W₂ = Final weight of sample after drying Sample,

g

3.3 Protein (%)

The protein content of *Mathri* sticks sample prepared by Tender Jackfruit flour of treatment composition (C₁-C₅) and frying temperature (T₁-T₃) determined by Micro-Kjeldahl distillation method (AOAC, 1980). The sample were digested by heating with concentrated sulphuric acid (H₂SO₄) in the presence of digestion mixture, Potassium sulphate (K₂SO₄) and Copper sulphate (CuSO₄). The mixture was made alkaline with 40% NaOH. Ammonium sulphate thus formed. Released ammonia which collected in 4% boric acid solution and titrated again with standard HCL. The percent nitrogen content of the sample was calculated by the formula given below. Protein content was calculated by using equation (2) and (3):

$$\% \text{ N} = \frac{(1.4 \times (\text{ml Hcl} - \text{ml blank}) \times \text{Conc. of HCL})}{\text{Weight of Sample (g)}} \quad \dots (2)$$

$$\% \text{ Protein} = \% \text{ N} \times \text{Factor (6.25)} \quad (3)$$

3.4 Fat (%)

Fat content of *Mathri* sticks sample prepared by Tender Jackfruit flour of treatment composition (C₁-C₅) and frying temperature (T₁-T₃) using solvent extraction in a Soxhlet apparatus as described (AOAC, 2000) five grams of crushed product were carefully weighed in a thimble and defatted with petroleum ether placed in a Soxhlet reflux flask which is connected to a condenser on the upper side and to a weighted oil extraction flask full with two hundred mili petroleum ether. The ether was brought to its boiling point the vapour condensed into the reflux flask immersing the samples completely for extraction to take place on filling up the reflux flask siphons over carrying the oil extract back to the boiling solvent in the flask. The process of boiling, condensation, and reflux was allowed to go for hours before the defatted samples were removed. The oil extract in the flux was dried in the oven 60° for thirty minutes and weighted. The experiment was repeated for three times replication. Using the following formula Eq (4) the fat content can be determined

$$\text{Crude fat content (g/100g)} = \frac{W_2 - W_1}{W} \times 100 \quad (4)$$

Where,

W = Weight of thimble, g

W₁ = Weight of empty beaker, g

W₂ = Weight of beaker with final extracted oil, g

3.5 Ash (%)

Ash content of *Mathri* sticks sample prepared by Tender Jackfruit flour of treatment composition (C₁-C₅) and frying temperature (T₁-T₃) using determined using (AOAC, 2000) A crucible were dried and cooled in desiccators before weighing. Five grams of the *Mathri* sticks sample were weighted into the crucible and the weight was taken. The crucible containing the *Mathri* sticks were placed into the muffle furnace at 550 °C. This temperature was maintained for four

hours. The muffle furnace was allowed to cool; the crucible was then brought out; the left residue was weighed after cooled down. The ash content was calculated as follows by Eq (5) the experiment was repeated for three times for replication the average reading.

Using the following formula Eq (5) the ash content can be determined

$$\text{Ash content (\%)} = \frac{(W_2 - W_1)}{(\text{Weight of sample})} \times 100 \quad (5)$$

Where,

W₂ = Weight of crucible + ash,

W₁ = Weight of empty crucible

3.6 Fiber (%)

The crude fiber content of *Mathri* sticks samples prepared by using Tender Jackfruit flour (C₁-C₅) and processed at different frying temperatures (T₁-T₃) was determined according to the method described by the Association of Official Analytical Chemists (AOAC, 2000) using a fat free sample.

Initially, clean crucibles were dried in a hot air oven, cooled in a desiccator, weighed, and their weights were recorded. Approximately 5 g of the sample was accurately weighed and transferred into the crucibles, which were then placed in the metal adapters of the hot air oven.

A volume of 150 ml of 1.25% Sulphuric acid (H₂SO₄) was added to the extraction unit. The samples were digested in the acid medium for 40 min under controlled heating conditions. After digestion, the acid solution was drained, and the residue was washed thoroughly with distilled water three times to remove any residual acid.

Subsequently, 150 ml of 1.25% Sodium hydroxide (NaOH) solution was added, and the samples were digested for another 40 min. After alkali digestion, the solution was drained, and the residue was washed three times with distilled water to remove alkali traces.

The crucibles containing the digested residue were removed and dried in a hot air oven until a constant weight was obtained. The crucibles were cooled in a desiccator and weighed to obtain the weight of residue before ignition (W₁). Thereafter, the crucibles were placed in a muffle furnace at 550 °C for 4 hrs. for ashing. After ashing, the crucibles were cooled in a desiccator and weighed again to obtain the weight of residue after ignition (W₂). The crude fibre was calculated from the loss in weight during ignition using the following equation (6)

$$\text{Fiber (\%)} = \frac{(W_1 - W_2)}{(W)} \times 100 \quad (6)$$

Where,

W₁ = Weight of residue before ignition (g)

W₂ = Weight of residue after ignition (g)

W = Weight of sample taken for analysis (g)

3.7 Colour

The Colour of *Mathri* sticks sample prepared by Tender Jackfruit flour of treatment composition (C₁-C₅) and frying temperatures (T₁-T₃) using determined using (CIE method 1976) measure using a colorimeter (M/s Konika Minolta, Japan Model- Meter CR -400) The equipment was calibrated by placing on the white tile in dark room. The *Mathri sticks* powder was prepared and placed in the petri-dish and keeping the Colori reader on the top of the product and colour was measured. Colour measurement of *Mathri* sticks was done by using (M/s Konika Minolta) and expressed in terms of L, a, b. L represents the brightness from white (100) to black (0). Red to green colour component was indicated by the 'a' value and yellow to blue colour components were indicated by the 'b' values.

3.8 Carbohydrate

Carbohydrate content in *Mathri sticks sample* prepared from Tender Jackfruit flour composition (C₁-C₅) and frying temperatures (T₁-T₃) determined by a subtracting the total sum of protein, fiber, ash and fat from 100 of the product sample (AOAC, 2000) The carbohydrate was calculated by using following equation (7)

$$\% \text{Carbohydrate} = 100 - (\% \text{protein} + \% \text{fat} + \% \text{fiber} + \% \text{ash} + \% \text{moisture content}) \quad (7)$$

3.9 Energy

Energy content *Mathri* sticks sample prepared from Tender Jackfruit flour composition determined (C_1 – C_5) and frying temperatures (T_1 – T_3) by Nwabueze (2007). The total energy value (kcal) was calculated

$$\text{Energy (kcal/g)} = [(9 \times \text{fat}) + (4 \times \text{carbohydrate}) + (4 \times \text{protein})] \quad (8)$$

3.10 Texture analyzer

Texture analysis of *Mathri* sticks sample prepared by using Tender Jackfruit flour for treatment composition (C_1 – C_5) and frying temperatures (T_1 – T_3) were carried out using a Texture Analyzer (M/S Stable Micro Systems, UK, Model: TA. HD Plus,) equipped with a 5 kg load cell following the method (Chauhan *et al.*, 2022.) [9] The texture analysis was done by using texture analyzer, M/S Stable Micro System, UK,) 5.0 probe was used, Pre- test speed was 3.0 mm/sec, post- test speed was 10.00 mm/sec. Distance maintained 23.00 mm, Trigger type was Auto (force). Texture analysis was performed on a total of 16 *Mathri* stick samples, comprising 15 treatment combinations obtained from five Tender Jackfruit flour formulations (C_1 – C_5) evaluated at three frying temperatures (T_1 – T_3), along with one control sample (T_6).

The texture property was evaluated by determining the maximum force required to break the *Mathri* sample (breaking strength), which indicates its crispness. The force–deformation curves obtained during the test were used for texture evaluation.

3.11 Sensory evaluation

Mathri sticks samples prepared from Tender Jackfruit flour for treatment combination were fried in sunflower oil at three different frying temperatures (130 °C, 140 °C, and 150 °C). After frying, the samples were allowed to cool to ambient temperature and were served on plates for sensory evaluation. The sensory assessment was conducted by a trained panel comprising students and staff members of the Post Graduate Institute of Post Harvest Management, Killa-Roha, Raigad. The panel evaluated the samples for colour, flavor, taste, texture, and overall acceptability using a 9-point hedonic scale. To eliminate bias,

by using the micronutrient composition. The Energy was calculated by using following equation (8)

all samples were randomly coded with alphanumeric identifiers before evaluation.

3.12

Statistical Analysis

Experimental design used for statistical analysis was Factorial Completely Randomized Design (FCRD). Two-way ANOVA at $p \leq 0.05$ was used to determine the statistical significance of result. The research data was statistically analyzed by following method described by Panse *et al.* (1967) [10].

4. Result and discussion

4.1 Effect of concentration (%) of tender jackfruit flour-whole wheat flour and frying temperature (°C) on frying time (minutes) of Mathri sticks

The effect of various concentration of Tender Jackfruit flours (i.e. 10%, 16%, 22%, 28%, 34%): Whole Wheat Flour (i.e. 90%, 84%, 78%, 72%, 66%) and frying temperature (i.e. 130 °C, 140 °C, 150 °C) on the frying time (minutes), of Tender Jackfruit flour *Mathri* sticks. The frying time for *Mathri* sticks was in the range of for all concentration were range of 3.26 ± 0.25 to 6.66 ± 0.15 minutes. As concentration of Tender Jackfruit flour increases frying time increased for all the frying temperature of the *Mathri* sticks. As the frying temperature increased from 130 °C to 150 °C the frying time showed decreasing trend from 5.33 ± 0.153 - 3.5 ± 0.10 , 5.53 ± 0.15 - 3.60 ± 0.10 , 6.06 ± 0.15 - 3.26 ± 0.25 , 6.36 ± 0.15 - 3.70 ± 0.10 , 6.66 ± 0.15 - 4.067 ± 0.15 at C_1 , C_2 , C_3 , C_4 and C_5 respectively.

As frying temperature increases the frying time decreases. As both the concentration of Tender Jackfruit flour and frying temperature increases the frying time decreases, showed decreasing trend.

Table 2. ANOVA for the effect of concentration (%) of dried Tender Jackfruit flour and Temperature (°C) on frying time (min) of *Mathri* sticks

Temperature (°C) Concentration (%)	T1	T2	T3	Mean A
C_1	5.333 ± 0.153	4.467 ± 0.153	3.500 ± 0.100	4.433
C_2	5.533 ± 0.153	4.800 ± 0.100	3.600 ± 0.100	4.644
C_3	6.067 ± 0.153	5.400 ± 0.100	3.267 ± 0.252	4.911
C_4	6.367 ± 0.152	5.567 ± 0.153	3.700 ± 0.100	5.211
C_5	6.667 ± 0.153	5.600 ± 0.100	4.067 ± 0.153	5.444
Mean B	5.993	5.167	3.627	
Control		4.167 ± 0.153		
Factor	C.D.			SE (m)
Factor (A)	0.139			0.048
Factor (B)	0.108			0.037
Factor (A×B)	0.241			0.083

Tender Jackfruit flour: Whole Wheat Flour ($C_1 = 10:90$, $C_2 = 16:84$, $C_3 = 22:78$, $C_4 = 28:72$, $C_5 = 34:66$) Frying Temperature T_1 - 130°C, T_2 - 140°C, T_3 - 150°C)

Table.2 shows the ANOVA for effect of concentration of Tender Jackfruit flour (%) and frying temperature (°C) ($C_1 = 10\%$, $C_2 = 16\%$, $C_3 = 22\%$, $C_4 = 28\%$, $C_5 = 34\%$) on frying time (min) of raw jackfruit flour *Mathri* sticks. It can be observed that the effect of concentration of Tender Jackfruit flour on frying time (min) was significant at $p <$

0.05. Similarly, the effect of frying temperature (i.e., T_1 - 130°C, T_2 - 140°C, T_3 - 150°C) on frying time (min) of raw jackfruit flour *Mathri* sticks was significant at $p < 0.05$. The combine effect of both concentration (%) and temperature (°C) of frying-on-frying time (min) was also significant at $p < 0.05$.

Shokrollahi *et al.* (2019) [11] reported that the formulation in deep crust model that the levels were 10%, 25%, and 50% wheat flour replacement with lentil or chickpea flour, and the frying time levels in

creases 0, 1.5, 3, 4.5, and 6 minutes respectively. The increase in frying time as formulation level increases due to higher water binding capacity while increased frying time reduced moisture and increased crispness. Similarly, *Bhuiyan et al. (2024)* [12] reported that the formulation levels were 1:1.1, 1:1.3, and 1:1.5 batter solid-to-water ratios (SWR), and the frying time levels were 2, 4, and 6 minutes significantly affected the textural properties of the meat-analog-based coated fried product. The solid formulation level increases frying time increases hardness, textural crispiness, and hardness in fried product. *Idowu et al. (2017)* [13] reported that increasing the flour formulation (20% to 40% African yam bean seed flour) and frying time 8 to 12 minutes effect on Kokoro (fried product) quality result in moisture loss and non-enzymatic browning increasing crispness. The optimum condition of 30% flour incorporation and 11.5 min frying at 155 °C which produce desirable crispness, sensory quality and colour. *Ogami et al. (2025)* [14] reported that for a fried coating for deep fried foods, increasing the frying temperature from 150 °C to 180 °C significantly reduced the time required to reach a temperature at 4.5 to 2.5 minutes in surfactant-free oil. This reduction is driven higher water vapor pressure, which accelerates surface water evaporation and promotes the expansion of the coating. Result in the product achieves a desirable brittle, crisp texture more rapidly with less browning; however, the accelerated evaporation results in higher crude oil content due to the formation of a more porous surface layer. *Gamble et al. (1987)* [15] evaluated the relationship between oil uptake and moisture loss during the deep-fat frying of 1.5 mm thick potato slices. Their findings demonstrate that as the oil temperature increases, the required frying time to reach optimum dryness decreases significantly at frying at 145 °C requires 4.5 to 5.0 minutes, elevating the temperature to 165 °C reduces the time to 3.0 to 3.5 minutes, and further raising the temperature to 185 °C drops the total frying time down to 1.8 to 2.0 minutes. *Omidiran et al. (2016)* [16] observed that the interaction between brewers spent cassava flour (BSCF) concentration and frying time affected the textural and color characteristics of the fried product. Increasing BSCF concentration with prolonged frying resulted in a crisper product and reduced oil absorption, which may be attributed to the development of a compact crust that limited oil penetration. Prolonged frying also increased colour intensity because of greater browning reactions. *(Al Jumayi and Darwish, 2021)* [17] reported that the interaction between defatted soybean flour concentration and frying time significantly influenced the quality of barley-soybean chips. Increasing the flour concentration along with prolonged frying time resulted in greater changes in the product quality.

4.2 Effect of concentration (%) of tender jackfruit flour and whole wheat flour and frying temperature (°C) on moisture content of Mathri sticks

The effect of various concentration of Tender Jackfruit flours (i.e.10%,16%,22%,28%,34%): Whole Wheat Flour (i.e. 90%, 84%, 78%, 72%, 66%) and frying temperature (i.e. 130°C, 140°C, 150°C) on the moisture content, of Tender Jackfruit flour *Mathri* sticks. The moisture content of *Mathri* sticks was in the range of 2.609 ± 0.008 (%) - 7.147 ± 0.119 (%). As concentration of Tender Jackfruit flour increases moisture content increased for all the frying temperature of *Mathri* sticks. As the frying temperature increased from 130 °C to

150 °C the moisture content showed decreasing trend from 4.19 ± 0.002 - 2.609 ± 0.008 , 5.103 ± 0.041 - 3.915 ± 0.009 , 5.659 ± 0.034 - 4.282 ± 0.036 , 6.852 ± 0.058 - 4.266 ± 0.119 and 7.147 ± 0.119 - 6.802 ± 0.095 at C₁, C₂, C₃, C₄ and C₅ respectively. As frying temperature increases the moisture content decreases. As both the concentration of Tender Jackfruit flour and frying temperature increases the moisture content showed increasing trend.

Tender Jackfruit flour: Whole Wheat Flour (C₁ = 10:90, C₂ = 16:84, C₃ = 22:78, C₄ = 28:72, C₅ = 34:66) Frying Temperature T₁- 130°C, T₂- 140°C, T₃- 150°C)

Table.3 shows the ANOVA for effect of concentration of Tender Jackfruit flour (%) and frying temperature (°C) (C₁ = 10%, C₂ = 16%, C₃ = 22%, C₄ = 28%, C₅ = 34%) (°C) on moisture content of raw jackfruit flour *Mathri* sticks. It can be observed that the effect of concentration of Tender Jackfruit flour on moisture content was significant at $p < 0.05$. Similarly, the effect of frying temperature (i.e., T₁- 130°C, T₂- 140°C, T₃- 150°C) on moisture content of raw jackfruit flour *Mathri* sticks was significant at $p < 0.05$.

Similar result was reported by *Omidiran et al., 2016* [16] fried snack made from Wheat flour and cassava flour as concentration of Cassava flour increase by 10 % the moisture content increases from 7.78%–13.16%. It may due to formation of a surface crust during frying which restrict moisture loss and help retain more moisture inside the product. *(Goel et al., 2018)* [18] reported that increasing the potato level in buckwheat chip formulation increased the moisture content of the fried chips. It may due to the higher water-binding and moisture-retention capacity of potato, which helps retain more moisture in the product during frying. *(Wang et al., 2018)* [19] reported that increasing whole wheat flour (WWF) substitution from 0, 25, 50, 75, 100% increased the moisture content from 8.20% to 12.40% in fried Sachima sticks. This increase was attributed to the higher dietary fibre of Whole Wheat flour, which has greater water-binding capacity and retains more moisture. *(Fetuga et al., 2014)* [20] reported that moisture content of yellow- fleshed sweet potato crisps decrease from 3.83% to 0.49% as frying temperature increases from 150 °C to 180 °C. This may be related to the increased heat-transfer rate at elevated frying temperatures, which accelerates moisture evaporation; consequently, the appropriate moisture level and crispness are obtained in a shorter frying time. It was observed as *Debnath et al. (2003)* [21] reported that as frying temperature increases from 150 °C to 200 °C the moisture content decreases of chickpea ribbon snacks from 0.070% to 0.003 %. This could be because higher frying temperatures accelerate the transmission of heat and moisture, which causes rapid moisture loss and shortens the time needed to achieve the appropriate crispness. *Nhan et al. (2024)* [22] reported that Wheat- Taro Snack moisture decreases 3.46 ± 0.08 to 3.14 ± 0.09 as temperature increases from 130°C 135°C 140°C. This could be because of increased moisture and quick evaporation at higher frying temperatures, which causes the product to lose more moisture. *Yuksel et al. (2014)* [23] reported that the combined effect of flaxseed flour concentration and frying temperature influenced the moisture content of wheat chips. An increase in frying temperature promoted greater moisture loss through evaporation, while the addition of flaxseed flour affected the ability of the product to retain moisture. Therefore, the interaction of both factors resulted in changes in the final moisture content of the fried chips.

Table 3. ANOVA for the Effect of concentration (%) of dried Tender Jackfruit flour and Temperature (°C) on moisture content of *Mathri* sticks

Temperature (°C) Concentration (%)	T1	T2	T3	Mean A
C ₁	4.193 ± 0.002	3.955 ± 0.088	2.609 ± 0.008	3.586
C ₂	5.103 ± 0.041	4.905 ± 0.010	3.915 ± 0.009	4.641
C ₃	5.659 ± 0.034	5.721 ± 0.178	4.282 ± 0.036	5.221
C ₄	6.852 ± 0.058	6.000 ± 0.219	4.266 ± 0.119	5.706
C ₅	7.147 ± 0.119	6.999 ± 0.132	6.802 ± 0.095	6.983
Mean B	5.791	5.516	4.375	

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Temperature (°C) Concentration (%)	T1	T2	T3	Mean A
Control		4.368 ± 0.044		
Factor	C.D.		SE (m)	
Factor (A)	0.095		0.032	
Factor (B)	0.073		0.025	
Factor (A×B)	0.164		0.056	

4.3 Effect of concentration (%) of tender jackfruit flour and whole wheat flour and frying temperature (°C) on protein content of Mathri sticks

The effect of various concentration of Tender Jackfruit flours (i.e. 10%, 16%, 22%, 28%, 34%): Whole Wheat Flour (i.e. 90%, 84%, 78%, 72%, 66%) and frying temperature (i.e. 130°C, 140°C, 150°C) on the protein (%), of Tender Jackfruit flour *Mathri* sticks. The protein content of *Mathri* sticks was in the range of 6.761 ± 0.026 (%) - 11.157 ± 0.028 (%). As concentration of Tender Jackfruit flour in *Mathri* sticks increases protein content increased for all the frying temperature of the *Mathri* sticks. As the frying temperature increased from 130°C to 150°C the protein content showed decreasing trend from 7.59 ± 0.02 - 6.76 ± 0.02 , 8.18 ± 0.03 - 7.18 ± 0.35 , 9.08 ± 0.10 - 7.60 ± 0.01 , 10.04 ± 0.02 - 8.959 ± 0.028 , 11.157 ± 0.028 - 9.831 ± 0.042 at C₁, C₂, C₃, C₄ and C₅ respectively. As frying temperature increases the protein content decreases. As both the concentration of Tender Jackfruit flour and frying temperature increases the protein content increases.

Tender Jackfruit flour: Whole Wheat Flour (C₁ = 10:90, C₂ = 16:84, C₃ = 22:78, C₄ = 28:72, C₅ = 34:66) Frying Temperature T₁- 130°C, T₂- 140°C, T₃- 150°C)

Table.4 shows the ANOVA for effect of concentration of Tender Jackfruit flour (%) and frying temperature (°C) (C₁ = 10%, C₂ = 16%, C₃ = 22%, C₄ = 28%, C₅ = 34%) on protein content % of raw jackfruit flour *Mathri* sticks. It can be observed that the effect of concentration of Tender Jackfruit flour on protein content was significant at $p < 0.05$. Similarly, the effect of frying temperature (i.e., T₁- 130°C, T₂- 140°C, T₃- 150°C) on protein content % of raw jackfruit flour *Mathri* sticks was significant at $p < 0.05$. The combine effect of both concentration (%) and temperature (°C) of frying on protein content (°C) was also significant at $p < 0.05$.

Oyedele *et al.* (2019) [24] reported that the chin-chin fried composite flour prepared from wheat, orange fleshed sweet potato, pigeon pea, as the concentration of pigeon pea flour increases from 15% to 30%, the protein content in the flour blends increases from 11.73% to 13.50%. The increase in protein content may be attributed to the incorporation of pigeon pea flour, which is a protein-rich legume. Thus, increasing the proportion of pigeon pea flour increased the protein contribution of the composite flour and consequently improved the protein content of the chin-chin a fried product. Ahmad *et al.* (2017) [25] reported that as multipurpose flour-based snack food as concentration of moong flour and urad flour increases from 2.5% to 7.5% the protein content increases from 17.98% to 18.63%. The increase in protein content may be attributed to the higher protein contribution of moong and urad flours. Their incorporation also increased the hardness of the fried snack without adversely affecting its colour and overall acceptability. Omidiran *et al.* (2016) [16] reported the effect of frying tem-

perature 140 °C–160 °C on the protein content of fried snacks from blends of wheat and brewers' spent cassava flour, as the frying temperature increases from 140 °C–160 °C the protein content of the snacks decreases from 9.22% to 8.65%. The decline in protein concentration with rising frying temperatures could be linked to heat-induced denaturation and breakdown of proteins, leading to a drop in the detectable protein content of the fried snack. Yodkraisri *et al.* (2012) [26] reported the effect of frying temperature 180 °C–200 °C on the protein content of lotus rhizome chips; as the frying temperature increases from 180 °C to 200 °C, the protein content of the chip's decreases from 4.78% to 3.44%. This decline might due to heightened thermal exposure at higher frying temperatures, potentially causing the modification of heat-sensitive protein elements, hence resulting in reduced protein levels. (Omidiran *et al.*, 2020) reported the effect of frying temperature 170 °C–180 °C on protein content of cassava starch and soy protein isolate snacks, as the frying temperature increases from 170 °C to 180 °C the protein content of snacks decreases from 6.34% to 4.38%. This could be because of increased heat exposure at the higher frying temperature, which causes heat-induced modifications to protein components and a decrease in the amount of protein that is measured. (Borse *et al.*, 2014) [27], bitter gourd chips protein content decreases from 2.79% to 2.26% and 1.58%, respectively, when the frying temperature was raised from 140 °C to 160 °C and 180 °C. Ahmad *et al.* (2022) [28] reported that the interaction of flour protein content and frying temperature influenced the quality of fried paratha rolls. Higher protein levels under increased frying temperatures favored Maillard reactions and acrylamide formation, while the functional properties of proteins contributed to changes in product structure and texture.

4.4 Effect of concentration (%) of tender jackfruit flour and whole wheat flour and frying temperature (°C) on fat content of Mathri sticks

The effect of various concentration of Tender Jackfruit flours (i.e. 10%, 16%, 22%, 28%, 34%): Whole Wheat Flour (i.e. 90%, 84%, 78%, 72%, 66%) and frying temperature (i.e. 130°C, 140°C, 150°C) on the fat (%), of Tender Jackfruit flour *Mathri* sticks. The fat of *Mathri* sticks was in the range of 28.438 ± 0.320 (%) - 43.975 ± 0.075 (%). As concentration of Tender Jackfruit flour increases fat content increased for all the frying temperature of *Mathri* sticks. As the frying temperature increased from 130°C to 150°C the fat content showed decreasing trend from 31.28 ± 0.032 - 29.56 ± 0.007 , 31.56 ± 0.19 - 28.43 ± 0.32 , 35.44 ± 0.66 - 33.48 ± 0.42 , 36.89 ± 0.16 - 34.93 ± 0.25 , 43.97 ± 0.07 - 41.67 ± 0.27 for C₁, C₂, C₃, C₄ and C₅ respectively. As frying temperature increases the fat content decreases for all concentration of Tender Jackfruit flour as both the concentration of Tender Jackfruit flour and frying temperature increases the fat content increases. Showed increasing trend.

Table 4. ANOVA for the Effect of concentration (%) of dried Tender Jackfruit flour and Temperature (°C) on Protein content of *Mathri* sticks

Temperature (°C) Concentration (%)	T1	T2	T3	Mean A
C ₁	7.596 ± 0.028	7.318 ± 0.028	6.761 ± 0.028	7.225
C ₂	8.182 ± 0.031	7.596 ± 0.073	7.188 ± 0.354	7.655
C ₃	9.089 ± 0.105	8.115 ± 0.042	7.606 ± 0.016	8.270
C ₄	10.045 ± 0.028	9.850 ± 0.028	8.959 ± 0.028	9.618

(continued on next page)

Temperature (°C) Concentration (%)	T1	T2	T3	Mean A
C ₅	11.157 ± 0.028	10.935 ± 0.028	9.831 ± 0.042	10.641
Mean B	9.214	8.763	8.069	
Control		6.789 ± 0.028		
Factor	C.D.		SE (m)	
Factor (A)	0.098		0.034	
Factor (B)	0.076		0.026	
Factor (A×B)	0.169		0.058	

Tender Jackfruit flour: Whole Wheat Flour (C₁ = 10:90, C₂ = 16:84, C₃ = 22:78, C₄ = 28:72, C₅ = 34:66) Frying Temperature T₁- 130°C, T₂- 140°C, T₃- 150°C)

Table 5. ANOVA for the effect of Concentration (%) of Tender Jackfruit flour-based and frying temperature (°C) on Fat in *Mathri* sticks

Temperature (°C) Concentration (%)	T1	T2	T3	Mean A
C ₁	31.281 ± 0.032	30.328 ± 0.024	29.562 ± 0.007	30.390
C ₂	31.562 ± 0.192	29.370 ± 0.347	28.438 ± 0.320	29.790
C ₃	35.448 ± 0.667	33.817 ± 0.407	33.481 ± 0.428	34.248
C ₄	36.898 ± 0.161	35.957 ± 0.182	34.931 ± 0.250	35.929
C ₅	43.975 ± 0.075	42.819 ± 0.118	41.670 ± 0.277	42.821
Mean B	35.833	34.458	33.616	
Control		34.525 ± 0.101		
Factor	C.D.		SE (m)	
Factor (A)	0.282		0.097	
Factor (B)	0.218		0.075	
Factor (A×B)	0.488		0.168	

Table 5 shows the ANOVA for effect of concentration of Tender Jackfruit flour (%) and frying temperature (°C) (C₁ = 10%, C₂ = 16%, C₃ = 22%, C₄ = 28% C₅ = 34%) (°C) on Fat content % of raw jackfruit flour *Mathri* sticks. Similarly, the effect of frying temperature (i.e., T₁- 130°C, T₂- 140°C, T₃- 150°C) on Fat content % of raw jackfruit flour *Mathri* sticks was significant at p < 0.05. The combine effect of both concentration (%) and temperature (°C) of frying on Fat content (°C) was also significant at p < 0.05.

Fat content of Tender Jackfruit flour increases in incorporation of Tender Jackfruit flour from 10% to 34% respectively Because during the frying process moisture evaporates from the food, creating pores and surface ruptures in the substrate, since the oil is absorbed into these voids to replace the lost water and does not evaporate, the relative proportion of fat increases as the starch and carbohydrate content of the flour increases (Ouchon *et al.*, 2003) [2]. Singh *et al.* (2022) [29] noted that elevating the amaranth grain flour proportion from 30% to 60% raised the fat content of sev from 21.27% to 30.03%. This could be due to increased oil absorption during deep frying, leading to a greasier and crispier texture of the fried sev until golden brown colour appear. (Patel *et al.*, 2019) [30] discovered that increasing the proportion of soy and Kodo flour from 0% to 50% resulted in an increase in the fat content of sev from 4.20% to 10.20%. This increase may be attributed to improved oil absorption during deep-fat frying, which contributes to higher fat levels in the final product. Virginia *et al.* (2014) [31] reported that *Mathri*'s fat content increased from 29.56g to 38.56 g/100 g with an increase in their incorporation of amaranth and watermelon seeds from 0 to 30% (20% amaranth seeds+ 10% watermelon seeds). This increase may be due to the greater fat contribution of the amaranth and watermelon seed flour, which increased the overall fat content of the *Mathri*. Singh *et al.* (2019) [32] indicated that the fat content of *Mathri* rise from 26.2 to 44.8 g/100 g as the proportion of soybean flour used as a substitute for refined wheat flour increased from 25% to 100%. This rise can be result of greater fat content present in soybean flour, which subse-

quently elevated the total fat content of the *Mathri* with higher levels of formulation. Deb *et al.* (2022) [33] says that the fat content in multilayered snacks made from wheat flour decreases from 28.20% to 24.07% when the frying temperature was raised from 160 to 190 °C for a duration of 5 minutes. This reduction can be attributed to the development of a firmer surface crust at elevated temperatures, which limited the penetration of oil and, as a result, decreased the oil absorption by the product. Ravi *et al.* (2004) [34] reported that the interactive effect of flour concentration and frying conditions influenced fat uptake in deep-fried boondi. At 36–44% solids concentration, lower flour levels resulted in a more porous and oilier product, whereas concentrations above 40% solids produced a firmer and less porous product with lower oil absorption. The effect of frying temperature was associated with moisture loss and crust development, which affected oil penetration and the final fat content of the fried product.

4.5 Effect of concentration (%) of tender jackfruit flour and whole wheat flour and frying temperature (°C) on ash content of *Mathri* sticks

The effect of various concentration of Tender Jackfruit flours (i.e. 10%,16%,22%,28%,34%): Whole Wheat Flour (i.e. 90%,84%,78%,72%,66%) and frying temperature (i.e. 130°C, 140°C, 150 °C) on the ash content (%), of Tender Jackfruit flour *Mathri* sticks. The ash of *Mathri* sticks was in the range of 2.469 ± 0.031 (%) - 3.352 ± 0.031 (%). As concentration of Tender Jackfruit flour increases ash content showed initial increasing followed by decreasing trend for all frying temperature. As the frying temperature increased from 130°C to 150°C the ash content showed increasing trend from 2.92 ± 0.06 - 3.30 ± 0.11, 3.27 ± 0.01 - 3.37 ± 0.04, 3.29 ± 0.02 - 3.32 ± 0.04, 2.46 ± 0.03 - 2.84 ± 0.05, 2.832 ± 0.047 - 3.038 ± 0.0 at C₁, C₂, C₃, C₄ and C₅ respectively. As frying temperature increases the ash content increases. As both the concentration of Tender Jackfruit flour and frying temperature increases the ash content Showed increasing initial followed by decreasing trend.

Tender Jackfruit flour: Whole Wheat Flour ($C_1 = 10:90$, $C_2 = 16:84$, $C_3 = 22:78$, $C_4 = 28:72$, $C_5 = 34:66$) Frying Temperature ($T_1 = 130^\circ\text{C}$; $T_2 = 140^\circ\text{C}$; $T_3 = 150^\circ\text{C}$)

Table 6. ANOVA for the Effect of concentration (%) of dried Tender Jackfruit flour and Temperature ($^\circ\text{C}$) on Ash content of *Mathri* sticks

Temperature ($^\circ\text{C}$) Concentration (%)	T1	T2	T3	Mean A
C_1	2.925 ± 0.067	2.522 ± 0.042	3.308 ± 0.113	2.919
C_2	3.279 ± 0.012	3.340 ± 0.035	3.372 ± 0.049	3.330
C_3	3.294 ± 0.025	3.352 ± 0.031	3.321 ± 0.048	3.322
C_4	2.469 ± 0.031	2.826 ± 0.020	2.844 ± 0.050	2.713
C_5	2.832 ± 0.047	2.955 ± 0.047	3.038 ± 0.033	2.942
Mean B	2.960	2.999	3.177	
Control		2.366 ± 0.055		
Factor	C.D.		SE (m)	
Factor (A)	0.047		0.016	
Factor (B)	0.037		0.012	
Factor (A×B)	0.082		0.028	

Table 6 shows the ANOVA for effect of concentration of Tender Jackfruit flour (%) and frying temperature ($^\circ\text{C}$) ($C_1 = 10\%$, $C_2 = 16\%$, $C_3 = 22\%$, $C_4 = 28\%$, $C_5 = 34\%$) ($^\circ\text{C}$) on Ash content (%) of raw jackfruit flour *Mathri* sticks. It can be observed that the effect of concentration of Tender Jackfruit flour on protein content was significant at $p < 0.05$. Similarly, the effect of frying temperature (i.e., T_1 - 130°C , T_2 - 140°C , T_3 - 150°C) on Ash content (%) of raw jackfruit flour *Mathri* sticks was significant at $p < 0.05$. The combine effect of both concentration (%) and temperature ($^\circ\text{C}$) of frying on ash content ($^\circ\text{C}$) was also significant at $p < 0.05$. According to Kayode *et al.* (2025) [35], the ash content of fried chin-chin made with wheat flour mixed with African palmyra palm shoot flour decreased from 1.32% to 1.04% as the incorporation level rise from 10% to 50%. African palmyra palm shot flours comparatively reduced mineral contribution when compared to wheat flour may be the cause of the ash content decline. Mallick *et al.* (2014) [36] found that the ash content of fried unripe banana based Sev decreased gradually with increased incorporation of unripe banana pulp. The ash content reduced from 0.49% in S0 (0% unripe banana pulp) to 0.47% in S1 (10%), 0.45% in S2 (20%), 0.43% in S3 (30%), and 0.40% in S4 (40%). This decrease could be due to the substitution of the chickpea flour by unripe banana pulp, leading to a lower total mineral contribution of the formulation. Fetuga *et al.* (2014) [20] reported the effect of frying temperature 150°C - 180°C on ash content of sweet potato crisps, as the frying temperature increases from 150°C - 180°C the ash content of sweet potato crisps increases from 2.00 % to 4.50 %. The increase in ash content with frying temperature was observed, which could be explained by moisture loss at higher frying temperature, concentrating the mineral fraction on a dry-weight basis and leading to a higher percentage of ash. Saputri *et al.* (2022) [37] reported that the ash content in vacuum fried fruit chips was range from 1.68 to 3.52 % with in-

crease in temperature and greater water evaporation during processing which was vacuum fried at 80°C . At higher temperatures the water evaporates more rapidly and the non-volatile mineral constituents in the product are concentrated. Thus, the ash content increases with the increase in frying temperature. Omidiran *et al.* (2016) [16] observed that the combined effect of flour concentration and frying temperature influenced the ash content and quality attributes of the fried product. The ash content varied between 2.0–3.0%, while the optimized product containing 32% BSCF and fried at 140°C for 4 min recorded 2.00% ash. Changes in flour concentration and frying temperature also influenced the colour, texture and oil absorption of the product, which may be related to variations in flour composition, moisture loss, crust development and browning reactions during frying.

4.6 Effect of concentration (%) of tender jackfruit flour and whole wheat flour and frying temperature ($^\circ\text{C}$) on fibre content of *Mathri* sticks

The effect of various concentration of Tender Jackfruit flours (i.e. 10%,16%,22%,28%,34%): Whole Wheat Flour (i.e. 90%,84%,78%,72%,66%) and frying temperature (i.e. 130°C , 140°C , 150°C) on the fibre content, of Tender Jackfruit flour *Mathri* sticks. The fibre content of *Mathri* sticks was in the range of 2.84 ± 0.009 (%) - 4.454 ± 0.039 (%). As concentration of Tender Jackfruit flour increases fibre content increases for all the temperature of frying as the frying temperature increased from 130°C to 150°C the fibre (%) content showed decreasing trend from 3.248 ± 0.002 - 3.096 ± 0.002 , 3.462 ± 0.029 - 2.842 ± 0.009 , 3.716 ± 0.022 - 3.102 ± 0.014 , 4.125 ± 0.018 - 3.147 ± 0.122 , 4.454 ± 0.039 - 3.484 ± 0.017 (%), C_1 , C_2 , C_3 , C_4 and C_5 respectively. As frying temperature increases the fibre content decrease as both the concentration of Tender Jackfruit flour and frying temperature increases the fibre content showed increasing trend which can be seen from Shown increasing trend.

Table 7. ANOVA for the Effect of concentration (%) of dried Tender Jackfruit flour and Temperature ($^\circ\text{C}$) on Fiber content of *Mathri* sticks

Temperature ($^\circ\text{C}$) Concentration (%)	T1	T2	T3	Mean A
C_1	3.248 ± 0.002	3.194 ± 0.005	3.096 ± 0.002	3.180
C_2	3.462 ± 0.029	3.113 ± 0.028	2.842 ± 0.009	3.139
C_3	3.716 ± 0.022	3.387 ± 0.016	3.102 ± 0.014	3.402
C_4	4.125 ± 0.018	3.654 ± 0.027	3.147 ± 0.122	3.642
C_5	4.454 ± 0.039	3.918 ± 0.012	3.484 ± 0.017	3.952
Mean B	3.801	3.453	3.134	
Control		1.225 ± 0.115		

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Temperature (°C) Concentration (%)	T1	T2	T3	Mean A
Factor	C.D.		SE (m)	
Factor (A)	0.036		0.012	
Factor (B)	0.028		0.010	
Factor (A×B)	0.062		0.021	

Tender Jackfruit flour: Whole Wheat Flour ($C_1 = 10:90$, $C_2 = 16:84$, $C_3 = 22:78$, $C_4 = 28:72$, $C_5 = 34:66$) Frying Temperature T_1 - 130°C, T_2 - 140°C, T_3 - 150°C)

Table.7 shows the ANOVA for effect of concentration of Tender Jackfruit flour (%) and frying temperature (°C) ($C_1 = 10\%$, $C_2 = 16\%$, $C_3 = 22\%$, $C_4 = 28\%$, $C_5 = 34\%$) (°C) on Fibre content (%) of raw jackfruit flour *Mathri* sticks. It can be observed that the effect of concentration of Tender Jackfruit flour on protein content was significant at $p < 0.05$. Similarly, the effect of frying temperature (i.e., T_1 - 130°C, T_2 - 140°C, T_3 - 150°C) on Fibre content (%) of raw jackfruit flour *Mathri* sticks was significant at $p < 0.05$. The combine effect of both concentration (%) and temperature (°C) of frying on fibre content (°C) was also significant at $p < 0.05$. Similar result was observed by Jood *et al.* (2024) [38] for spinach leaves powder supplemented sev. As the concentration of spinach leaves powder increases 4% to 10%, the crude fiber content of the sev increased from 3.45 to 4.45%. The increase in crude fiber may be due to the higher fiber content of spinach leaves powder. With the increase in the level of incorporation the more cellulose and other dietary fiber components were added to the sev and thus the crude fiber content was higher. Gupta *et al.* (2011) [39] reported that the dietary fiber content of *Mathri* increased from 5.75 to 9.01% with an increase in the incorporation of dehydrated amaranth leaf powder from 0 to 12%. This increase may be attributed to the higher dietary fiber content of amaranth leaf powder, which contributed additional fiber to the *Mathri* as its level of incorporation increased. (Fetuga *et al.*, 2014) [20] when the frying temperature was raised from 150 °C to 180 °C, the fiber content of sweet potato crisps dropped from 1.99% to 0.49%. This decrease could be explained by the breakdown of some heat-sensitive fiber fractions during frying due to the thermal degradation of fiber components at higher frying temperatures. (Adebawale *et al.*, 2013) [40], trifoliate yam chips fiber content dropped from 1.47 to 1.27% when the frying temperature was raised from 160 to 180 °C. This decline could be explained the fiber components thermal deterioration at higher frying temperatures. (Kayacier *et al.*, 2014) [41] found that the interaction of fiber concentration, frying temperature and frying time affected the ash content of wheat chips supplemented with fiber. The ash content ranged between 0.34 and 0.52%, with the highest value of 0.52% obtained using 15% fiber, 190 °C frying temperature and 50 sec. frying time. This increase may be associated with the higher mineral content contributed by the added fiber and the concentration of minerals following moisture loss during frying.

4.7 Effect of concentration (%) of tender jackfruit flour and whole wheat flour and frying temperature (°C) on energy of *Mathri* sticks

The effect of various concentration of Tender Jackfruit flours (i.e. 10%, 16%, 22%, 28%, 34%): Whole Wheat Flour (i.e. 90%, 84%, 78%, 72%, 66%) and frying temperature (i.e. 130°C, 140°C, 150°C)

on the Energy (kcal), of Tender Jackfruit flour *Mathri* sticks. The Energy of *Mathri* sticks was in the range of 513.847 ± 1.879 - 576.541 ± 1.589 (g). As concentration of Tender Jackfruit flour increases Energy increases for all the frying temperature as the frying temperature increased from for all the frying temperature as the frying temperature increased from 130°C to 150°C the Energy showed decreasing trend from 527.93 ± 0.34 - 524.12 ± 0.47 , 524.16 ± 0.96 - 516.72 ± 1.59 , 546.147 ± 11.053 - 536.993 ± 2.260 , 547.208 ± 1.09 - 546.216 ± 1.103 , 576.333 ± 0.639 - 576.541 ± 1.589 (kcal) at C_1 , C_2 , C_3 , C_4 and C_5 respectively. As the frying temperature increases the Energy decreases. As both the concentration of Tender Jackfruit flour and frying temperature increases the Energy content.

Tender Jackfruit flour: Whole Wheat Flour ($C_1 = 10:90$, $C_2 = 16:84$, $C_3 = 22:78$, $C_4 = 28:72$, $C_5 = 34:66$) Frying Temperature ($T_1 = 130^\circ\text{C}$; $T_2 = 140^\circ\text{C}$; $T_3 = 150^\circ\text{C}$)

Table.8 shows the ANOVA for effect of concentration of Tender Jackfruit flour (%) and frying temperature (°C) ($C_1 = 10\%$, $C_2 = 16\%$, $C_3 = 22\%$, $C_4 = 28\%$, $C_5 = 34\%$) (°C) on Energy (kcal/100 g) of raw jackfruit flour *Mathri* sticks. It can be observed that the effect of concentration of Tender Jackfruit flour on Energy (kcal/100 g) was significant at $p < 0.05$. Similarly, the effect of frying temperature (i.e., T_1 - 130°C, T_2 - 140°C, T_3 - 150°C) on Energy (kcal/100 g) of raw jackfruit flour *Mathri* sticks was significant at $p < 0.05$. Kusum *et al.* (2023) [42], reported that *Mathri*'s energy content rise as the amount of brown top millet flour added increased, reaching 412.83 kcal/100 g at 40% inclusion (BTMF3). The higher protein and fat content of brown top millet flour, as well as the absorption of oil during deep-frying, may be responsible for the product's enhanced energy content. Wadmare *et al.* (2025) [1], reported that using multigrain flour blends raised *Mathri* energy content rises from 482 to 497 kcal/100 g. This rise may be explained by the composite grains' increased supply of components that provide energy, especially fat and protein, which raises the multigrain *Mathri*'s overall energy value. Asogwa *et al.* (2026) [43] reported that the energy content of air-fried chin-chin increased from 453.55 to 462.27 kcal/100 g with an increase in okara flour incorporation from 0 to 30%. The increase may be attributed to the higher contribution of energy-yielding nutrients, particularly protein and fat, from okara flour. The study says that progressive increase in protein and fat contents with increasing okara substitution, which contributed to the higher calculated energy value. Namirah *et al.* (2025) [44] reported that the energy content of oyster mushroom chips decreased from 509.99 to 494.72 kcal/100 g as frying temperature increased from 150 to 155 °C. This decrease may be attributed mainly to the lower fat content at the higher frying temperature, which reduced the contribution of fat to the calculated energy value.

Table 8. ANOVA for the effect of concentration (%) of dried Tender Jackfruit flour and Temperature (°C) on Energy (kcal/100 g) of *Mathri* sticks

Temperature (°C) Concentration (%)	T1	T2	T3	Mean A
C_1	527.934 ± 0.344	529.950 ± 0.195	524.142 ± 0.472	527.342
C_2	524.164 ± 0.966	513.847 ± 1.879	516.725 ± 1.598	518.245
C_3	546.147 ± 11.053	532.927 ± 2.476	536.993 ± 2.260	538.689

(continued on next page)

Temperature (°C) Concentration (%)	T1	T2	T3	Mean A
C ₄	547.208 ± 1.095	544.480 ± 1.388	546.216 ± 1.103	545.968
C ₅	576.333 ± 0.639	574.281 ± 0.735	576.541 ± 1.589	575.718
Mean B	544.357	539.097	540.123	
Control		534.007 ± 0.607		
Factor	C.D.		SE (m)	
Factor (A)	3.044		1.049	
Factor (B)	2.358		0.813	
Factor (A×B)	5.273		1.817	

4.8 Effect of concentration (%) of tender jackfruit flour and whole wheat flour and frying temperature (°C) on carbohydrate of Mathri sticks

The effect of various concentration of Tender Jackfruit flours (i.e. 10%, 16%, 22%, 28%, 34%); Whole Wheat Flour (i.e. 90%, 84%, 78%, 72%, 66%) and frying temperature (i.e. 130°C, 140°C, 150°C) on the Carbohydrate, of Tender Jackfruit flour *Mathri* sticks. The carbohydrate of *Mathri* sticks was in the range of 33.98 ± 0.05 - 58.009 ± 0.142 (%). As concentration of Tender Jackfruit flour increases carbohydrate decreases for all the frying temperature of *Mathri* sticks. As the frying temperature increased from 130°C to 150°C the carbohydrate showed increasing trend from at 54.004 ± 0.104 - 57.760 ± 0.098 (%), 51.874 ± 0.180 - 58.009 ± 0.142 (%), 47.688 ± 1.80 - 51.320 ± 0.423 (%), 43.737 ± 0.087 - 48.999 ± 0.324 (%), 33.981 ± 0.052 - 40.545 ± 0.193 (%), at C₁, C₂, C₃, C₄ and C₅ respectively. As the frying temperature increases the Carbohydrate increases for all the concentration of tender jackfruit flour. As both the concentration of Tender Jackfruit flour and frying temperature increases the Carbohydrate showed decreasing trend.

Tender Jackfruit flour: Whole Wheat Flour (C₁ = 10:90, C₂ = 16:84, C₃ = 22:78, C₄ = 28:72, C₅ = 34:66) Frying Temperature (T₁ =

130°C; T₂ = 140°C; T₃ = 150°C)

Table 9 shows the ANOVA for effect of concentration of Tender Jackfruit flour (%) and frying temperature (°C) (C₁ = 10%, C₂ = 16%, C₃ = 22%, C₄ = 28%, C₅ = 34%) (°C) on carbohydrate of raw jackfruit flour *Mathri* sticks. It can be observed that the effect of concentration of Tender Jackfruit flour on was significant at p < 0.05. Similarly, the effect of frying temperature (i.e., T₁- 130°C, T₂- 140°C, T₃- 150°C) on carbohydrate of raw jackfruit flour *Mathri* sticks was significant at p < 0.05. The combine effect of both concentration (%) and temperature (°C) of frying on carbohydrate was also significant at p < 0.05. Similar results were observed as Omidiran *et al.*, (2016) [16] found that as the concentration of wheat and cassava flour increased, the carbohydrate content decreased from 69.11% to 67.73% in fried snack. This decline may be linked to the changes in the ratio of other nutrients in the formulation, which in turn lowered the relative carbohydrate level of the product. Fetuga *et al.*, (2014) [20] indicated that the carbohydrate level in yellow-fleshed sweet potato crisps rise from 62.17% to 74.97% as the frying temperature was elevated from 150 to 180 °C. This rise may be linked to increased moisture evaporation during frying, which intensified the carbohydrate concentration on a dry-weight basis.

Table 9. ANOVA for the effect of concentration (%) of dried Tender Jackfruit flour and Temperature (°C) on Carbohydrate of *Mathri* sticks

Temperature (°C) Concentration (%)	T1	T2	T3	Mean A
C ₁	54.004 ± 0.104	56.931 ± 0.036	57.760 ± 0.098	56.232
C ₂	51.874 ± 0.180	54.784 ± 0.315	58.009 ± 0.142	54.889
C ₃	47.688 ± 1.800	49.028 ± 0.338	51.320 ± 0.423	49.345
C ₄	43.737 ± 0.087	45.366 ± 0.132	48.999 ± 0.324	46.034
C ₅	33.981 ± 0.052	36.292 ± 0.101	40.545 ± 0.193	36.939
Mean B	46.257	48.480	51.326	
Control		53.530 ± 0.105		
Factor	C.D.		SE (m)	
Factor (A)	0.492		0.170	
Factor (B)	0.381		0.131	
Factor (A×B)	0.853		0.294	

4.9 Effect of concentration (%) of tender jackfruit flour and whole wheat flour and frying temperature (°C) on hardness (N) of Mathri sticks

The effect of various concentration of Tender Jackfruit flours (i.e. 10%, 16%, 22%, 28%, 34%); Whole Wheat Flour (i.e. 90%, 84%, 78%, 72%, 66%) and frying temperature (i.e. 130°C, 140°C, 150°C) on the Hardness, of Tender Jackfruit flour *Mathri* sticks. The Hardness of *Mathri* sticks was in the range of 78.788 ± 1.173 - 352.651 ± 2.255 (N). As concentration of Tender Jackfruit flour increases Hardness increases for all the frying temperature of the

Mathri sticks. As the frying temperature increased from 130 °C to 150°C the Hardness showed decreasing trend from at 194.16 ± 3.13 - 78.78 ± 1.17, 202.87 ± 1.85 - 160.112 ± 1.56, 207.81 ± 1.91 - 145.0 ± 1.68, 344.732 ± 2.176 - 170.0 ± 1.687, 352.65 ± 2.25 - 200.16 ± 1.61 (N) at C₁, C₂, C₃, C₄ and C₅ respectively. As the frying temperature increases the Hardness decreases. As both the concentration of Tender Jackfruit flour and frying temperature increases the Hardness decreases for all the concentration.

Tender Jackfruit flour: Whole Wheat Flour (C₁ = 10:90, C₂ = 16:84, C₃ = 22:78, C₄ = 28:72, C₅ = 34:66) Frying Temperature (T₁ = 130°C; T₂ = 140°C; T₃ = 150 °C

Table 10. ANOVA for effect of concentration (%) of dried Tender Jackfruit flour and Temperature (°C) on Hardness (N) in Mathri sticks

Temperature (°C)	T1	T2	T3	Mean A
Concentration (%)				
C ₁	194.160 ± 3.134	102.302 ± 1.625	78.788 ± 1.173	125.083
C ₂	202.872 ± 1.857	169.499 ± 1.557	160.112 ± 1.568	177.495
C ₃	207.817 ± 1.916	195.000 ± 1.541	145.000 ± 1.687	182.606
C ₄	344.732 ± 2.176	230.000 ± 2.012	170.000 ± 1.687	248.244
C ₅	352.651 ± 2.255	277.445 ± 1.611	200.160 ± 1.619	276.752
Mean B	260.447	194.849	150.812	
Control		71.341 ± 1.471		
Factor	C.D.		SE (m)	
Factor (A)	25.654		8.840	
Factor (B)	19.872		6.847	
Factor (A×B)	44.434		15.311	

Table 10 shows the ANOVA for effect of concentration of Tender Jackfruit flour (%) and frying temperature (°C) (C₁ = 10%, C₂ = 16%, C₃ = 22%, C₄ = 28%, C₅ = 34%) (°C) on Hardness (N) of raw jackfruit flour *Mathri* sticks. It can be observed that the effect of concentration of Tender Jackfruit flour on *was* significant at $p < 0.05$. Similarly, the effect of frying temperature (i.e., T₁- 130°C, T₂- 140°C, T₃- 150°C) on Hardness (N) of raw jackfruit flour *Mathri* sticks was significant at $p < 0.05$. The combine effect of both concentration (%) and temperature (°C) of frying on Hardness (N) was also significant at $p < 0.05$. In the study reports by Li *et al.*, (2023) [45] increasing the proportion of cassava flour progressively enhanced the hardness of the fried product, rising from 2,320.33 g at 0% substitution to 5,376.33 g at 50%. This rise in hardness can be attributed to the dilution of gluten-forming proteins and the high water-binding capacity of the cassava flour. Consequently, the development of the gluten network was inhibited, resulting in a denser and firmer product structure. Ndala *et al.* (2019) [46] found that as the proportion of wheat bran (WB) in the flour composition increased (from 5% to 20%), the instrumental hardness of the magwinya significantly increased. Specifically, the hardness value rise from 475.94 g to 667.14 g in the formulation with 20% wheat bran. This increase in hardness is attributed to gluten-starch interactions, starch retrogradation, and interaction between gluten and the fibrous materials introduced by the bran. Parvar *et al.* (2014) [47] observed that for this fried pellet product as the frying temperature increased from 150 °C to 190 °C, the hardness values decreased from 1686.7 g to 542.3 g for yellow pellets and from 1458.7 g to 482.4 g for green pellets. The reason for this reduction in hardness in the puffing of the samples and a decrease in crust thickness, which occurs because high temperatures cause water within the pellet to turn into steam in an explosive manner, expanding the product's structure. According to Omidiran *et al.*, (2016) [16] it was observed that for wheat-brewers spent cassava flour (BSCF) fried snacks, as the frying temperature increased from 140 °C to 160 °C, the texture (hardness) values significantly decreased from 60.10 N to 30.10 N (for samples with 20% BSCF and 3 mm thickness fried for 3 minutes). The reason is reduction is that higher frying temperatures enhance crust formation and increase the crispness of the snack. During this process, moisture leaves the food as vapor bubbles, which creates an expanded, porous structure as the matrix traps water vapor,

ultimately resulting in a lower force required to reach the fracture point. Kayacier *et al.*, (2014) [41] observed that for this fried chip, as the frying temperature increased from 170 °C to 190 °C, the hardness values decreased from 267.03 N to 142.04 N for chips with a 7.5% fiber level and from 179.44 N to 133.55 N for chips without fiber. The reason for this reduction is that during the deep fat frying process, the inner moisture is converted to steam, which creates a pressure gradient; as water evaporates, the pore internal pressure reduces and the product develops its internal structure. Furthermore, higher frying temperatures can lead to a decrease in the force required to break the sample, as variations in moisture content and composition influence the elasticity and structural resistance of the final chip. Yuksel *et al.* (2016) [48] found that the interaction of stale bread flour level, frying temperature and frying time affected the hardness of wheat chips. The study used 0–50% stale bread flour, frying temperatures of 170–190 °C, and frying times of 40–60 sec. Higher flour incorporation resulted in a firmer product, whereas increasing frying temperature generally reduced hardness. These changes were mainly attributed to moisture loss and structural modifications during frying, which influenced the texture of the chips.

4.10 Effect of concentration (%) of tender jackfruit flour and whole wheat flour and frying temperature (°C) on colour (L) of Mathri sticks

The effect of various concentration of Tender Jackfruit flours (i.e. 10%, 16%, 22%, 28%, 34%): Whole Wheat Flour (i.e. 90%, 84%, 78%, 72%, 66%) and frying temperature (i.e. 130°C, 140°C, 150°C) on the Colour (L) value of Tender Jackfruit flour *Mathri* sticks. The Colour (L) value of *Mathri* sticks was in the range of 31.96 ± 0.23 - 60.424 ± 0.33 %. As concentration of Tender Jackfruit flour increases Colour (L) value decreases for all frying temperature. As the frying temperature increased from 130 °C to 150 °C the Colour (L) value showed decreasing trend from at 60.42 ± 0.33 - 44.35 ± 0.37, 55.10 ± 0.11 - 39.04 ± 0.13, 50.06 ± 0.30 - 34.106 ± 0.458, 44.983 ± 0.150 - 36.46 ± 0.33, 40.010 ± 0.22 - 30.99 ± 0.24 at C₁, C₂, C₃, C₄ and C₅ respectively. As the frying temperature increases the Colour (L) value decreases. As both the concentration of Tender Jackfruit flour and frying temperature increases the Colour (L) value showed decreasing trend.

Table 11. ANOVA for effect of concentration (%) of dried Tender Jackfruit flour and Temperature (°C) on Colour (L) value in Mathri sticks

Temperature (°C)	T1	T2	T3	Mean A
Concentration (%)				
C ₁	60.424 ± 0.339	52.068 ± 0.215	44.359 ± 0.370	52.284
C ₂	55.106 ± 0.119	47.202 ± 0.324	39.046 ± 0.130	47.118
C ₃	50.066 ± 0.306	42.195 ± 0.121	34.106 ± 0.458	42.122
C ₄	44.983 ± 0.150	37.148 ± 0.299	36.463 ± 0.335	39.531

(continued on next page)

Temperature (°C) Concentration (%)	T1	T2	T3	Mean A
C ₅	40.010 ± 0.225	31.969 ± 0.236	30.997 ± 0.245	34.325
Mean B	50.118	42.116	36.994	
Control		56.914 ± 0.369		
Factor	C.D.		SE (m)	
Factor (A)	0.267		0.091	
Factor (B)	0.207		0.071	
Factor (A×B)	0.463		0.159	

Tender Jackfruit flour: Whole Wheat Flour Tender Jackfruit flour: Whole Wheat Flour (C₁ = 10:90, C₂ = 16:84, C₃ = 22:78, C₄ = 28:72, C₅ = 34:66)

Frying Temperature (T₁ = 130°C; T₂ = 140°C; T₃ = 150°C)

Table.11 shows the ANOVA for effect of concentration of Tender Jackfruit flour (%) and frying temperature (°C) (C₁ = 10%, C₂ = 16%, C₃ = 22%, C₄ = 28%, C₅ = 34%) (°C) on Colour (L) value of raw jackfruit flour *Mathri* sticks. It can be observed that the effect of concentration of Tender Jackfruit flour on *was* significant at $p < 0.05$. Similarly, the effect of frying temperature (i.e., T₁- 130°C, T₂- 140°C, T₃- 150°C) on Colour (L) of raw jackfruit flour *Mathri* sticks was significant at $p < 0.05$. The combine effect of both concentration (%) and temperature (°C) of frying on Colour (L) was also significant at $p < 0.05$. Singh *et al.* (2011) [49] reported that increasing the level of de-fatted soy flour from 3.33% (T₂) to 6.66% (T₃) and 9.99% (T₄) resulted in a progressive decrease in L values, indicating a reduction in the lightness of the Gulab jamun. This decline can be attributed to the darker color of the soy flour and intensified browning during frying, which yielded a darker finished product. Manjunatha *et al.*, (2014) [50] observed that the Hunter L (lightness) values of *Gethi strips* decreased progressively as frying temperatures rose, dropping from 54 at 120 °C to 48 at 140 °C, 42 at 160 °C, and 39 at 180 °C. This decline in L values, which signifies increased surface darkening at higher temperatures, is primarily driven by rapid moisture loss and Maillard-type non-enzymatic browning. Salehi, (2019) [51] demon-

strated that the L value, which represents lightness, significantly declines in kohlrabi slices as frying temperatures increase dropping from 52.39 at 140 °C to 32.30 at 200 °C. This reduction in the L value serves as a quantitative indicator of surface darkening. Such browning is primarily attributed to non-enzymatic reactions,

4.11 Effect of concentration (%) of tender jackfruit flour and whole wheat flour and frying temperature (°C) on colour (a) of Mathri sticks

The effect of various concentration of Tender Jackfruit flours (i.e. 10%, 16%, 22%, 28%, 34%): Whole Wheat Flour (i.e. 90%, 84%, 78%, 72%, 66%) and frying temperature (i.e. 130°C, 140°C, 150°C) on the Colour (a) value of Tender Jackfruit flour *Mathri* sticks. The Colour (a) value of *Mathri* sticks was in the range of 1.54 ± 0.01 - 4.347 ± 0.024 . As the concentration of Tender Jackfruit flour increases Colour (a) value increases for all frying temperature. As the frying temperature increased from 130 °C to 150 °C the Colour (a) value showed increasing trend from at C₁, C₂, C₃, C₄ and C₅ respectively. As the frying temperature increases the Colour (a) value showed increasing for all the concentration of Tender Jackfruit flour. As both the concentration of Tender Jackfruit flour and frying temperature increases the Colour (a) value 1.540 ± 0.018 - 3.133 ± 0.025 ; from 1.933 ± 0.016 - 3.150 ± 0.043 ; from 2.337 ± 0.019 - 3.363 ± 0.060 ; From 2.453 ± 0.03 - 3.450 ± 0.053 ; from 3.103 ± 0.031 - 4.347 ± 0.024 respectively for C₁, C₂, C₃, C₄ and C₅ Showed decreasing trend.

Table 12. ANOVA for Effect of concentration (%) of dried Tender Jackfruit flour and Temperature (°C) on Colour (a) value in Mathri sticks

Temperature (°C) Concentration (%)	T1	T2	T3	Mean A
C ₁	1.540 ± 0.018	2.130 ± 0.22	3.133 ± 0.025	2.268
C ₂	1.933 ± 0.016	2.513 ± 0.032	3.150 ± 0.043	2.532
C ₃	2.337 ± 0.019	2.520 ± 0.026	3.363 ± 0.060	2.740
C ₄	2.453 ± 0.035	3.273 ± 0.067	3.450 ± 0.053	3.059
C ₅	3.103 ± 0.031	3.363 ± 0.015	4.347 ± 0.024	3.604
Mean B	2.273	2.760	3.489	
Control		3.191 ± 0.145		
Factor	C.D.		SE (m)	
Factor (A)	0.065		0.022	
Factor (B)	0.051		0.017	
Factor (A×B)	0.113		0.039	

Tender Jackfruit flour: Whole Wheat Flour (C₁ = 10:90, C₂ = 16:84, C₃ = 22:78, C₄ = 28:72, C₅ = 34:66) Frying Temperature (T₁ = 130°C; T₂ = 140°C; T₃ = 150°C)

Table. 12 shows the ANOVA for effect of concentration of Tender Jackfruit flour (%) and frying temperature (°C) (C₁ = 10%, C₂ = 16%, C₃ = 22%, C₄ = 28%, C₅ = 34%) (°C) on Colour (a) value of raw jackfruit flour *Mathri* sticks. It can be observed that the effect of concentration of Tender Jackfruit flour on *was* significant at $p < 0.05$. Similarly, the effect of frying temperature (i.e., T₁- 130°C, T₂- 140°C, T₃- 150°C) on Colour (a) of raw jackfruit flour *Mathri* sticks was significant at $p < 0.05$. The combine effect of both concentration (%) and temperature (°C) of frying on Colour (a) was also significant at $p <$

0.05. Miranda *et al.*, (2018) [52] observed that an increase in the proportion of cactus pear peel powder substitution in gluten free snack resulted in a higher *a* value for the snack samples, signifying a transition toward increased redness. Specifically, *a* value rise from 6.72 ± 0.42 at a 5% substitution level to 10.37 ± 0.95 at 10%. This intensification of the red may be attributed to the presence of natural pigments, such as betalains and chlorophyll, within the cactus pear peel powder. Furthermore, the elevated temperatures during the frying process likely facilitate pigment transformation and non-enzymatic browning reactions, including the Maillard reaction, thereby further augmenting the red coloration of the final product. Ozcan *et al.* (2021) [53], reported that the fried chips redness increased when the

hulled lupin flour substitute was increased from 25–30% to 40–45%. The combination of the flour formulation with high frying temperatures may be responsible for this increase in redness, which intensifies the product's red hue by encouraging browning reactions. (Chauhan *et al.*, 2022) [9], a value of Mathri increased from 4.88 to 6.71, indicating greater redness, when the concentration of carnaubawax was increased from 5% to 15%. Maillard and non-enzymatic browning reactions during deep fat frying were responsible for this rise. (Sivaranjani *et al.*, 2024) [54], when the frying temperature rose, a value of ariselu snacks climbed from 9.55 at 150 °C to 12.5 at 170 °C and 18.0 at 190 °C, suggesting increasing redness. This was explained by the fact that at higher temperatures, non-enzymatic browning reactions accelerate. (Tri *et al.*, 2024), as the frying temperature rise from 130 °C, 140 °C, 150 °C the wheat-taro snacks a value rise from 8.00 to 8.21 and 8.48 indicating greater redness. This was explained by the intensification of browning caused by Maillard and caramelization reactions at higher temperatures.

4.12 Effect of concentration (%) of tender jackfruit flour-based and whole wheat flour and frying temperature (°C) on colour (b) value of Mathri sticks

The effect of various concentration of Tender Jackfruit flours (i.e. 10%, 16%, 22%, 28%, 34%): Whole Wheat Flour (i.e. 90%, 84%, 78%, 72%, 66%) and frying temperature (i.e. 130°C, 140°C, 150°C) on the Colour (b) value of Tender Jackfruit flour Mathri sticks. The Colour (b) value of Mathri sticks was in the range of 7.04 ± 0.02 - 27.230 ± 0.020 . As the concentration of Tender Jackfruit flour increases Colour (b) value increases for all the frying temperature as the frying temperature increased from 130°C to 150°C the Colour (b) value showed increasing trend from 7.04 ± 0.02 - 9.13 ± 0.01 , 10.35 ± 0.02 - 12.26 ± 0.03 , 15.20 ± 0.01 - 17.320 ± 0.01 , 19.14 ± 0.04 - 21.143 ± 0.031 , 25.227 ± 0.015 - 27.230 ± 0.020 at C₁, C₂, C₃, C₄ and C₅ respectively. As the frying temperature increases the Colour (b) showed value increasing trend at all concentration of Tender Jackfruit flour as both the concentration of Tender Jackfruit flour and frying temperature increases the Colour (b) increasing trend.

Table 13. ANOVA for the effect of concentration (%) of dried Tender Jackfruit flour and Temperature (°C) on Colour (b) value in Mathri sticks

Temperature (°C)	T1	T2	T3	Mean A
Concentration (%)				
C ₁	7.040 ± 0.026	8.140 ± 0.026	9.137 ± 0.015	8.106
C ₂	10.350 ± 0.020	11.147 ± 0.025	12.260 ± 0.036	11.252
C ₃	15.200 ± 0.010	16.153 ± 0.035	17.320 ± 0.010	16.224
C ₄	19.157 ± 0.042	20.230 ± 0.020	21.143 ± 0.031	20.177
C ₅	25.227 ± 0.015	26.233 ± 0.015	27.230 ± 0.020	26.230
Mean B	25.227	26.233	27.230	
Control		15.243 ± 0.031		
Factor	C.D.		SE (m)	
Factor (A)	0.024		0.008	
Factor (B)	0.019		0.006	
Factor (A×B)	0.042		0.014	

Tender Jackfruit flour: Whole Wheat Flour (C₁ = 10:90, C₂ = 16:84, C₃ = 22:78, C₄ = 28:72, C₅ = 34:66) Frying Temperature (T₁ = 130°C; T₂ = 140°C; T₃ = 150°C)

Table. 13 shows the ANOVA for effect of concentration of Tender Jackfruit flour (%) and frying temperature (°C) (C₁ = 10%, C₂ = 16%, C₃ = 22%, C₄ = 28%, C₅ = 34%) (°C) on Colour (b) value of raw jackfruit flour Mathri sticks. It can be observed that the effect of concentration of Tender Jackfruit flour on was significant at $p < 0.05$. Similarly, the effect of frying temperature (i.e., T₁- 130°C, T₂- 140°C, T₃- 150°C) on Colour (b) of raw jackfruit flour Mathri sticks was significant at $p < 0.05$. Maity *et al.*, (2012) reported that increasing semolina substitution from 5% to 15% increased the b value of the fried snack casing from 23.27 ± 0.05 to 25.98 ± 0.03 and 28.16 ± 0.07 , indicating greater yellow colour intensity. This increase may be attributed to the higher semolina content and the development of yellowish-brown colour during frying, mainly due to Maillard and other non-enzymatic browning reactions. Kumar *et al.*, (2015) reported that b values of Sev samples increased from 48.4 ± 0.5 (S1) to 51.6 ± 0.4 , indicating greater yellowness. The higher b value was attributed mainly to β-carotene pigments in chickpea (Bengal gram) flour and differences in formulation composition. Maity *et al.* (2014) [55] reported that vacuum fried jackfruit chips showed a significant and progressive increase in redness b value as the frying temperature increased. For a 0.5 cm thick sample at the final frying duration of 30.0 minutes, the redness values increased from 8.32 at 80 °C to 11.58 at 90 °C, finally reaching a high of 14.21 at 100 °C. This trend is attributed to nonenzymatic browning reactions and caramelization at higher temperatures, which increased the intensity of the golden-brown to dark-brown color during the frying process. Vaitkeviciene *et al.*, (2022) [56] reported that the b value of potato chips increased

from 14.12 at 160 °C to 17.51 at 180 °C, indicating greater yellowness, mainly due to Maillard browning at higher frying temperatures. Moghaddam *et al.*, (2015) [57] observed an increase in b value of pellet snacks from 19.32 at 150 °C to 22.92 at 190 °C, attributed to temperature-dependent Maillard reactions during frying.

4.13 Effect of concentration (%) of tender jackfruit flour and whole wheat flour and frying temperature (°C) on sensory property i.e. colour of Mathri sticks

Effect of various concentrations of Tender Jackfruit flour (i.e., 10%, 16%, 22%, 28%, 34%) and Whole Wheat Flour (90%, 84%, 78%, 72%, 66%) and frying temperature (i.e. 130°C, 140°C, 150°C) on the sensory colour of dried Tender Jackfruit flour Mathri sticks. It was observed that the range of sensory colour for all concentration and frying temperature was from 5.360 ± 0.230 to 8.480 ± 0.268 . Mathri sticks fried at temperature of temperature of 130 °C (T₁), 140°C (T₂), 150°C (T₃) are used concentration is 10% (C₁) has received sensory colour score of 7.340, 6.320, 7.220, respectively. Mathri sticks fried at temperature 130 °C (T₁), 140°C (T₂), 150°C (T₃) are used concentration is 16%(C₂) has received sensory colour score of 6.480, 7.280, 7.220, respectively. Mathri sticks fried at temperature of temperature of 130 °C (T₁), 140°C (T₂), 150°C (T₃) are used concentration is 22% (C₃) has received sensory colour score of 6.420, 7.340, 8.480, respectively. Mathri sticks fried at temperature 130 °C (T₁), 140°C (T₂), 150°C (T₃) for used concentration is 28%(C₄) has received sensory colour score of 6.340, 7.400, 5.360, respectively. Mathri stick fried at temperature 130 °C (T₁), 140°C (T₂), 150°C (T₃) are used concentration is 34%(C₅) has received sensory colour score of 6.460, 5.280, 6.400, respectively. From all five concentration and three frying temperature at 150°C, Treatment C3T3 gives higher sensory score, The

sensory score for control sample was 6.22. Colour of treatment C3T3 was liked by sensory panel. Table 14 shows the ANOVA for the effect of Concentration of Tender Jackfruit flour (%) and Temperature of frying on sensory colour of *Mathri* sticks. It can be observed that the effect of concentration of Tender Jackfruit flour % on sensory colour

was significant at $p \leq 0.05$. Similarly, the effect of frying temperature on colour was significant at $p \leq 0.05$. Combined effect of both Concentration of Tender Jackfruit flour (%) and Temperature of frying was also significant at $p \leq 0.05$.

Table 14. Effect of the Concentration (%) of Tender Jackfruit flour and Temperature (°C) on the Colour of *Mathri* Sticks

Temperature (°C) Concentration (%)	T1	T2	T3	Mean A
C ₁	7.340 ± 0.114	6.320 ± 0.239	7.220 ± 0.192	6.960
C ₂	6.480 ± 0.130	7.280 ± 0.192	7.220 ± 0.110	6.993
C ₃	6.420 ± 0.259	7.340 ± 0.114	8.480 ± 0.268	7.413
C ₄	6.340 ± 0.241	7.400 ± 0.274	5.360 ± 0.230	6.367
C ₅	6.460 ± 0.270	5.280 ± 0.192	6.400 ± 0.158	6.047
Mean B	6.608	6.724	6.936	
Control		6.220 ± 0.192		
Factor	C.D.		SE (m)	
Factor (A)	0.153		0.054	
Factor (B)	0.119		0.042	
Factor (A×B)	0.265		0.093	

Tender Jackfruit flour: Whole Wheat Flour (C₁ = 10:90, C₂ = 16:84, C₃ = 22:78, C₄ = 28:72, C₅ = 34:66) Frying Temperature T₁- 130°C, T₂- 140°C, T₃- 150°C).

4.14 Effect of concentration (%) of tender jackfruit flour and whole wheat flour and frying temperature (°C) on sensory property i.e. flavor of *Mathri* sticks

Effect of various concentrations of Tender Jackfruit flour (i.e., 10%,16% 22%, 28%,34%) and Whole Wheat Flour (90%, 84%, 78%, 72%, 66%) and frying temperature (i.e. 130°C, 140°C, 150°C) on the sensory flavor of dried Tender Jackfruit flour *Mathri* sticks. It was observed that the range of sensory flavor for all concentration and frying temperature was from 5.380 ± 0.130 to 8.220 ± 0.192. *Mathri* sticks fried at temperature of temperature of 130 °C (T₁), 140°C (T₂) .150°C (T₃) are used concentration is 10% (C₁) has received sensory flavor score of 7.280, 6.520, 7.360 respectively. *Mathri* sticks fried at temperature 130 °C (T₁), 140°C (T₂), 150°C (T₃) are used concentration

is 16% (C₂) has received sensory Flavor score of 6.480, 7.140, 6.400 respectively. *Mathri* sticks fried at temperature of temperature of 130 °C (R₁), 140°C (R₂), 150°C (R₃) are used concentration is 22% (T₃) has received sensory flavor score of 7.640, 7.600, 8.220 respectively. *Mathri* sticks fried at temperature 130 °C (T₁), 140°C (T₂), 150°C (T₃) are used concentration is 28% (C₄) has received sensory flavor score of 6.340, 7.300, 6.520, respectively. *Mathri* sticks fried at temperature 130°C (T₁), 140°C (T₂), 150°C (T₃) are used concentration is 34% (C₅) has received sensory flavor score of 7.300, 6.300, 5.380 respectively. The sensory score for control sample was 6.280 flavors treatment C3T3 was liked by sensory panel. Table 15 shows the ANOVA for the effect of Concentration of Tender Jackfruit flour (%) and Temperature of frying on sensory Flavor of *Mathri* sticks. It can be observed that the effect of concentration of Tender Jackfruit flour % on sensory Flavor was significant at $p \leq 0.05$. Similarly, the effect of frying temperature on flavor was significant at $p \leq 0.05$

Table 15. Effect of the Concentration (%) of Tender Jackfruit flour and Temperature (°C) on the flavor of *Mathri* Sticks

Temperature (°C) Concentration (%)	T1	T2	T3	Mean A
C ₁	7.280 ± 0.192	6.520 ± 0.130	7.360 ± 0.241	7.053
C ₂	6.480 ± 0.192	7.140 ± 0.114	6.400 ± 0.158	6.673
C ₃	7.640 ± 0.207	7.600 ± 0.158	8.220 ± 0.192	7.820
C ₄	6.340 ± 0.207	7.300 ± 0.158	6.520 ± 0.084	6.720
C ₅	7.300 ± 0.158	6.300 ± 0.158	5.380 ± 0.130	6.327
Mean B	7.008	6.972	6.776	
Control		6.280 ± 0.130		
Factor	C.D.		SE (m)	
Factor (A)	0.111		0.039	
Factor (B)	0.086		0.030	
Factor (A×B)	0.192		0.067	

Tender Jackfruit flour: Whole Wheat Flour (C₁ = 10:90, C₂ = 16:84, C₃ = 22:78, C₄ = 28:72, C₅ = 34:66) Frying Temperature T₁- 130°C, T₂- 140°C, T₃- 150°C).

4.15 Effect of concentration (%) of tender jackfruit flour and frying temperature (°C) on sensory property i.e. taste of

Mathri sticks

Effect of various concentrations of Tender Jackfruit flour (i.e., 10%,16% 22%, 28%,34%) and Whole Wheat Flour (90%, 84%,78%,72%,66%) and frying temperature (i.e. 130 °C , 140 °C , 150°C) on the sensory Taste of dried Tender Jackfruit flour *Mathri*

sticks. It was observed that the range of sensory Taste for all concentration and frying temperature was from 5.340 ± 0.114 to 8.300 ± 0.158 . *Mathri* sticks fried at temperature of temperature of 130 °C (T_1), 140°C (T_2), 150°C (T_3) are used concentration is 10% (C_1) has received sensory Taste score of 7.280, 6.500, 7.340 respectively. *Mathri* sticks fried at temperature 130 °C (T_1), 140°C (T_2), 150°C (T_3) are used concentration is 16% (C_2) has received sensory taste score of 6.400, 7.300, 6.400 respectively. *Mathri* sticks fried at temperature of temperature of 130 °C (T_1), 140°C (T_2), 150°C (T_3) are used concentration is 22% (C_3) has received sensory taste score of 7.180, 7.380, 8.300, respectively. *Mathri* sticks fried at temperature 130 °C (T_1), 140°C (T_2), 150°C (T_3) are used concentration is 28% (C_4) has received sensory taste score of 6.380, 7.300, 6.340, respectively. *Mathri* fried at temperature 130 °C (T_1), 140°C (T_2), 150°C

(T_3) are used concentration is 34% (C_5) has received sensory taste score of 6.260, 5.340, 6.280 ± 0.25 , respectively. From all five concentration and three frying temperature at 150 °C, Treatment C3T3 gives higher sensory score, The sensory score for control sample was 6.32 taste treatment C3T3 was liked by sensory panel. Table 16 shows the ANOVA for the effect of Concentration of Tender Jackfruit flour (%) and Temperature of frying on sensory Taste of *Mathri* sticks. It can be observed that the effect of concentration of Tender Jackfruit flour % on sensory Taste was significant at $p \leq 0.05$. Similarly, the effect of frying temperature on Taste was significant at $p \leq 0.05$. Similarly, the effect of frying temperature on Taste was significant at $p \leq 0.05$. Combined effect of both Concentration of Tender Jackfruit flour (%) and Temperature of frying was also significant at $p \leq 0.05$.

Table 16. ANOVA for the Effect of Concentration (%) of Tender Jackfruit flour-based and frying temperature (°C) Sensory property i.e. Taste of *Mathri* sticks

Temperature (°C) Concentration (%)	T1	T2	R3	Mean A
C ₁	7.280 ± 0.192	6.500 ± 0.158	7.340 ± 0.114	7.040
C ₂	6.400 ± 0.158	7.300 ± 0.158	6.400 ± 0.158	6.700
C ₃	7.180 ± 0.148	7.380 ± 0.130	8.300 ± 0.158	7.620
C ₄	6.380 ± 0.228	7.300 ± 0.158	6.340 ± 0.207	6.673
C ₅	6.260 ± 0.114	5.340 ± 0.114	6.280 ± 0.259	5.960
Mean B	6.700	6.764	6.932	
Control		6.320 ± 0.192		
Factor	C.D.		SE (m)	
Factor (A)	0.119		0.042	
Factor (B)	0.092		0.033	
Factor (A×B)	0.207		0.073	

Tender Jackfruit flour: Whole Wheat Flour ($C_1 = 10:90$, $C_2 = 16:84$, $C_3 = 22:78$, $C_4 = 28:72$, $C_5 = 34:66$) Frying Temperature T_1 - 130°C, T_2 - 140°C, T_3 - 150°C).

4.16 Effect of concentration (%) of tender jackfruit flour and frying temperature (°C) sensory property i.e. texture of *Mathri* sticks

Effect of various concentrations of Tender Jackfruit flour (i.e., 10%, 16%, 22%, 28%, 34%) and Whole Wheat Flour (90%, 84%, 78%, 72%, 66%) and frying temperature (i.e. 130°C, 140°C, 150°C) on the sensory Texture of dried Tender Jackfruit flour *Mathri* sticks. It was observed that the range of sensory Texture for all concentration and frying temperature was from 5.340 ± 0.860 to 8.300 ± 0.874 . *Mathri* fried at temperature of temperature of 130°C (T_1), 140°C (T_2), 150°C (T_3) are used concentration is 10% (C_1) has received sensory Texture score of 7.400, 6.380, 7.300 respectively. *Mathri* sticks fried at temperature 130 °C (T_1), 140°C (T_2), 150°C (T_3) are used concentration is 16% (C_2) has received sensory texture score of 6.500, 7.280,

6.400 respectively. *Mathri* sticks fried at temperature of temperature of 130°C (T_1), 140°C (T_2), 150°C (T_3) are used concentration is 22% (C_3) has received sensory texture score of 7.580, 7.460, 8.300 respectively. *Mathri* sticks fried at temperature 130 °C (T_1), 140°C (T_2), 150°C (T_3) are used concentration is 28% (C_4) has received sensory texture score of 6.540, 7.320, 5.340 respectively. *Mathri* fried at temperature 130°C (T_1), 140°C (T_2), 150°C (T_3) are used concentration is 34% (C_5) has received sensory texture score of 6.300, 7.480, 6.380 respectively. The sensory score for control sample was 6.44 texture treatment C3T3 was liked by sensory panel. Table 17 shows the ANOVA for the effect of Concentration of Tender Jackfruit flour (%) and Temperature of frying on sensory texture of *Mathri* sticks. It can be observed that the effect of concentration of Tender Jackfruit flour % on sensory texture was significant at $p \leq 0.05$. Similarly, the effect of frying temperature on texture was significant at $p \leq 0.05$. Similarly, the effect of frying temperature on texture was significant at $p \leq 0.05$. Combined effect of both Concentration of Tender Jackfruit flour (%) and Temperature of frying was also significant at $p \leq 0.05$.

Table 17. Effect of Concentration (%) of Tender Jackfruit flour-based and frying temperature (°C) Sensory property i.e. Texture of *Mathri* sticks

Temperature (°C) Concentration (%)	T ₁	T ₂	T ₃	Mean A
C ₁	7.400 ± 0.908	6.380 ± 0.899	7.300 ± 0.894	7.027
C ₂	6.500 ± 0.887	7.280 ± 0.884	6.400 ± 0.881	6.727
C ₃	7.580 ± 0.881	7.460 ± 0.872	8.300 ± 0.874	7.780
C ₄	6.540 ± 0.860	7.320 ± 0.851	5.340 ± 0.860	6.400
C ₅	6.300 ± 0.853	7.480 ± 0.854	6.380 ± 0.848	6.720
Mean B	6.864	7.184	6.744	
Control		6.440 ± 0.833		
Factor	C.D.		SE (m)	

(continued on next page)

Temperature (°C) Concentration (%)	T ₁	T ₂	T ₃	Mean A
Factor (A)	0.136		0.048	
Factor (B)	0.105		0.037	
Factor (A×B)	0.236		0.083	

Tender Jackfruit flour: Whole Wheat Flour (C₁ = 10:90, C₂ = 16:84, C₃ = 22:78, C₄ = 28:72, C₅ = 34:66) Frying Temperature T₁- 130°C, T₂- 140°C, T₃- 150°C).

4.17 Effect of concentration (%) of tender jackfruit flour and frying temperature (°C) sensory property i.e. overall acceptability of Mathri sticks

Effect of various concentrations of Tender Jackfruit flour (i.e., 10%, 16% 22%, 28%, 34%) and Whole Wheat Flour (90%, 84% 78% 72% 66%) and frying temperature (i.e. 130°C, 140°C, 150°C) on the sensory overall- acceptability of dried Tender Jackfruit flour *Mathri* sticks. It was observed that the range of sensory overall- acceptability for all concentration and frying temperature was from 5.400 ± 0.100 to 8.440. *Mathri* sticks fried at temperature of temperature of 130°C (T₁), 140°C (T₂), 150°C (T₃) are used concentration is 10% (C₁) has received sensory overall- acceptability score of 7.400, 6.540, 7.420 respectively. *Mathri* sticks fried at temperature 130°C (T₁), 140°C (T₂), 150°C (T₃) are used concentration is 16% (C₂) has received sensory overall- acceptability score of 6.380, 7.480, 7.520 respectively. *Mathri* sticks fried at temperature of temperature of 130°C (T₁),

140°C (T₂), 150°C (T₃) are used concentration is 22% (C₃) has received sensory overall- acceptability score of 7.400, 7.520, 8.440 respectively. *Mathri* sticks fried at temperature 130°C (T₁), 140°C (T₂), 150°C (T₃) are used concentration is 28% (C₄) has received sensory overall- acceptability score of 7.320, 7.340, 7.260 respectively. *Mathri* sticks fried at temperature 130°C (T₁), 140°C (T₂), 150°C (T₃) are used concentration is 34% (C₅) has received sensory overall- acceptability score of 6.380, 5.400, 5.480 respectively. From all five concentration and three frying temperature at 150°C, Treatment C3T3 gives higher sensory score, The sensory score for control sample was 6.30 overall- acceptability treatment C3T3 was liked by sensory panel. Table 18 shows the ANOVA for the effect of Concentration of Tender Jackfruit flour (%) and Temperature of frying on sensory overall- acceptability of *Mathri* sticks. It can be observed that the effect of concentration of Tender Jackfruit flour % on sensory overall- acceptability was significant at p ≤ 0.05. Similarly, the effect of frying temperature on texture was significant at p ≤ 0.05. Similarly, the effect of frying temperature on overall- acceptability was significant at p ≤ 0.05. Combined effect of both Concentration of Tender Jackfruit flour (%) and Temperature of frying was also significant at p ≤ 0.05.

Table 18. Effect of concentration (%) of dried Tender Jackfruit flour and Temperature (°C) sensory overall acceptability of *Mathri* sticks

Temperature (°C) Concentration (%)	T1	T2	T3	Mean A
C ₁	7.400 ± 0.158	6.540 ± 0.114	7.420 ± 0.192	7.120
C ₂	6.380 ± 0.192	7.480 ± 0.192	7.520 ± 0.259	7.127
C ₃	7.400 ± 0.245	7.520 ± 0.192	8.440 ± 0.195	7.787
C ₄	7.320 ± 0.179	7.340 ± 0.167	7.260 ± 0.182	7.307
C ₅	6.380 ± 0.192	5.400 ± 0.100	5.480 ± 0.335	5.753
Mean B	6.976	6.856	7.224	
Control		6.300 ± 0.187		
Factor	C.D.		SE (m)	
Factor (A)	0.134		0.047	
Factor (B)	0.104		0.036	
Factor (A×B)	0.231		0.081	

Tender Jackfruit flour: Whole Wheat Flour (C₁ = 10:90, C₂ = 16:84, C₃ = 22:78, C₄ = 28:72, C₅ = 34:66) Frying Temperature (T₁- 130°C, T₂- 140°C, T₃- 150°C).

4.18 Best treatment from the concentration and frying temperature of tender jackfruit flour *Mathri* sticks

Objective Parameter									L, a, b			Sensory Parameter				
M.C (%)	Protein (%)	Fat (%)	Ash (%)	Fiber (%)	Energy (Kcal)	Carbohydrate (%)	Hardness (N)	Frying time	L	a	b	Colour	Flavour	Taste	Texture	OA
4.282	7.606	33.48	3.321	3.102	536.993	51.320	145	3.267 min	34.106	3.363	17.320	8.48	8.22	8.3	8.3	8.44

The desirable properties of Tender Jackfruit flour i.e. moisture is low 4.28 %, protein is medium 7.6 %, fat is medium 33.48 %, ash is low 3.32 %, fibre is medium 3.10, energy is medium 536.993 (kcal), carbohydrate is medium 51.320 (%), hardness is low 145, colour (L, a, b) is low (34.106 3.363, 17.320), frying time is low (3.26 min) content has been achieved at concentration of flour (T3R3): 22%:78% (Tender Jackfruit flour and Whole Wheat Flour) and frying

temperature at 150 °C as discussed in table 19. Similarly, the best score for sensory colour, sensory flavour, sensory taste, sensory texture, and sensory overall acceptability have been observed as Tender Jackfruit flour and Whole Wheat Flour based *Mathri* sticks. Concentration (22%:78%), frying temperature at 150 °C and at as shown in fig respectively.

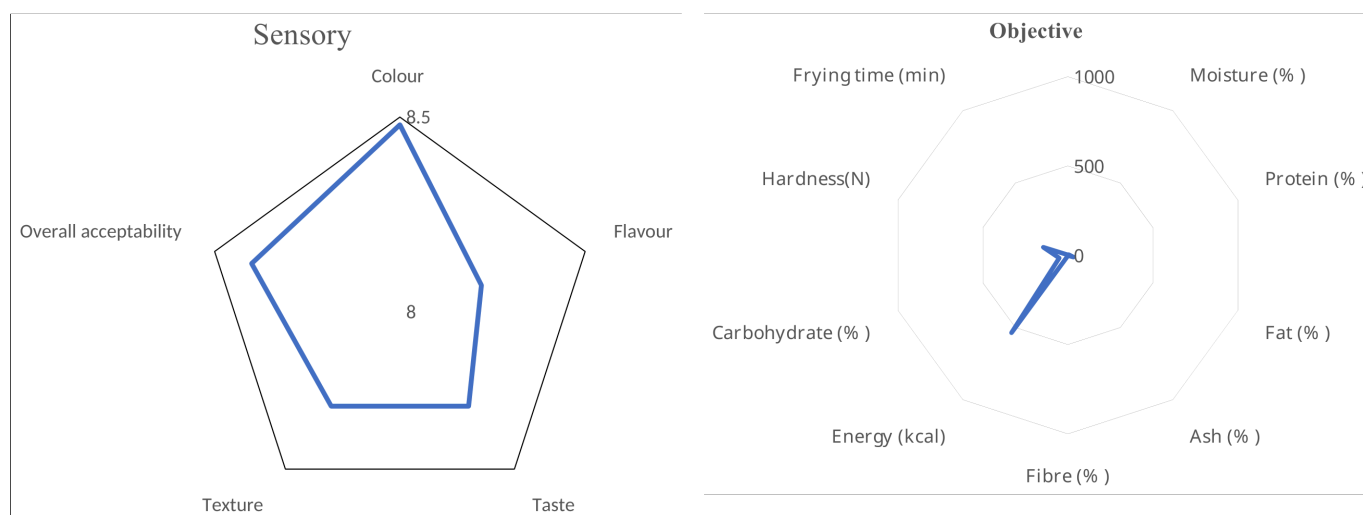


Figure 20. (a) Objective Parameter (b) Subjective Parameter for Best Treatment Concentration of flour (T3R3) $T_3 = 22\%:78\%$ (Whole Wheat Flour and Tender Jackfruit flour) and frying temperature 150°C

Conclusion

The *Mathri* sticks prepared from Tender Jackfruit flour and Whole Wheat Flour and quality evaluation revealed that the treatment T3R3 i.e. (22%:78%), frying temperature at 150°C. The *Mathri* stick properties having medium moisture content is 4.282 (%), Protein 7.606 (%), Ash- 3.32 (%), Fat- 33.48 (%), Fibre- 3.10 (%), Energy -536.993 kcal, Carbohydrate -51.32 (%), frying time - 3.26 (min), Colour (*L*, *a*, *b*) (34.10, 3.36, 17.32) respectively, Hardness 145. (N). At this best treatment the best sensory score was Colour, 8.48 %, Flavor, 8.22 %, Taste, 8.3%, Texture 8.3%, and overall acceptability 8.4 %,

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