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RESEARCH PAPER

Development of Breads from Convective Hot Air Dried Cashew Apple Flour and its Quality Evaluation

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ABSTRACT

The perishable cashew apple generates high amount waste residues and the wastage rate exceeds about 90% of production in India. Economic and efficient methods for handling and processing could help facing this problem through processing and transformation into good quality attractive products with extended shelf life. Baked products are good carrier for fibre enrichment, since they have become indispensable part of our life and are ideal for supplementation due to palatability, compactness, convenience and long shelf life of the product and being widely consumed by every individual irrespective of age. The bread was prepared from refined wheat flour and dried cashew apple flour composite as C1 (95:05%), C2 (90:10%), C3 (85:15%), C4 (80:20), C5 (75:25). The moisture content (33.270±0.02%), fat (2.160±0.01%), protein (5.170±0.01%), ash (0.375±0.03%**)**, fiber (2.150±0.03%), and carbohydrate (57.100±0.04%) respectively among the treatments. The colour and appearance, flavour, texture, taste and overall acceptability of dried cashew apple flour composite as 95:05%, 90:10% 85:15%, 80:20%, 75:25% varied significantly. The breads of treatment C1 i.e.95:05%. Refined wheat flour and cashew apple flour had obtained significantly higher score in all sensory attributes.

Keywords: Dried cashew apple flour, bread, proximate composition, sensory attributes

The cashew (*Anacardium occidentale* L.), a member of *Anacardiaceae* family, is a native of North East Brazil in Latin America. Being an evergreen tree of tropics, it is cultivated in more than 28 countries for its delightful nutritious kernels, apple and cashew nut shell liquid. Cashew is one of the major horticultural crops of Konkan region, mainly grown on hill slopes as rain-fed perennial crop. (Desai *et al.* 2010). Cashew apple is the succulent peduncle of the cashew fruit containing about 82 85% juice, 10-12% sugar, minerals and high level of vitamin C (Mini and Archana, 2016). Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth Dapoli, Maharashtra, has released and recommended the nine varieties of cashew i.e. Vengurla-1, Vengurla-2, Vengurla-3, Vengurla-4, Vengurla-5, Vengurla-6, Vengurla-7, Vengurla-8 and Vengurla-9, respectively (Bhuwad *et al.* 2017). 'Vengurla-4' is one of the preferred varieties by farmers of Konkan region because of larger size (> 7.5 g) of cashew nut and higher productivity. Cashew fruit comprises kidney shaped nut attached to the apple (cashew apple) which is technically a swollen peduncle. The cashew

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apple is about 6-7 times greater in weight than the raw nut (Salvi *et al.* 2016).

The trend in nutrition towards the consumption of functional foods and the continuous efforts to tackle food insecurity through reduction of food wastage at all stages have attracted the attention of researchers to cashew apple fiber or residue or pomace in the major cashew producing countries like Nigeria (Kayode and Adegunwa, 2019). Therefore, substitution of wheat flour with cashew apple powder will help achieve this aim and improve the nutritional quality of the composite flour for food uses. The aim of this study was to evaluate the proximate, functional and some micronutrients of cashew apple powder-whole wheat flour samples (Offia-Olua and Onwubiko, 2015).

The drying of cashew apple can be an excellent alternative to increase its shelf life. It allows conversion of perishable materials into stabilized products by lowering the water activity. It also prevents microbial spoilage. In addition, drying reduces waste and post-harvest losses the development of dried cashew apple powder, which maintain the relevant sensory properties, can contribute to the development of some value-added products which would be acceptable to the consumers (Ogunjobi and Ogunwolu, 2010).

Bread has always been one of the most popular and appealing food products due to its superior nutritional, sensorial and textural characteristics, ready to eat convenience as well as cost competitiveness. Bread is essential to the diets of many people worldwide (Sahin and Sumnu, 2006).

The ingredients of bread will impart characteristic colors, texture, and nutritional value which may improve the bread quality. Therefore, a proper balance of ingredients needs to be obtained to produce high-quality bread. Concerns about the quality of breads go beyond the ingredients in the loaves themselves. One of the main quality criteria on bread is related with texture, and the development of a desirable volume, related to alveoli formation

Baked products are good carrier for fibre enrichment, since they have become indispensable part of our life and are ideal for supplementation due to palatability, compactness, convenience and long shelf life of the product and being widely consumed by every individual irrespective of age (Sahni, 2017). There is an increasing demand for novel and healthy baked products by consumers who are now conscious of their well-being. Enrichment of wheat flour with cashew protein in bread production is one of such sources (Azeez *et al.* 2021).

This present study was thus undertaken with the objective of utilizing dried cashew apple flour for the development of breads from it and to study its quality evaluation.

MATERIALS AND METHODS

Materials

Cashew apple required for experimentation was collected from the Vengurla, Tal. Vengurla, Dist. Sindhudurg. The cashew apple was cleaned, washed with water and the damaged, infected apples were removed before beginning of experiments. The cashew apple slices of 'Vengurla-4' variety having 5 mm thickness, were dried in the convective hot air dryer at 50° up to 210 min. were grounded by using hammer mill (Make: M/S. Sagar Engineering Works Pvt. Ltd, Kudal) and pass through the 0.150 mm sieve to obtain dried cashew apple powder. The experimental work was carried out in Department of Post harvest Engineering of Post Graduate Institute of Post Harvest Technology and Management, Killa Roha.

Methods

1. Bread Making

Fig. 1. Shows the process technology for preparation of breads from dried cashew apple flour. The dried cashew apple flour of varied levels (5%, 10%, 15%, 20%, 25%) and refined wheat flour of varied levels (95%, 90%, 85%, 80%, 75%) were mixed together. Mixed well up to foam formation, which was defected through visual observation. The mixture was added with the sugar (6%), yeast (1.6%), improver (1.6%)

and salt (1.6%), edible oil (6%), water (50 ml) were used as per treatment combination to make flour composition, and it was added according to the treatment, and it was added into the earlier dough mass and the mixture was thoroughly mixed to a homogeneous mixture to form a dough. The dough poured into mould proofing well (R_h 80% temp. 40°). The mould were placed in baking tray and baked in oven at about 220°, 230° and 240° for 25 min. Control sample was procured from the market and considered as a control for comparison with the above treatments.

Fig. 1 shows the process flow chart for preparation of breads from dried cashew apple flour.

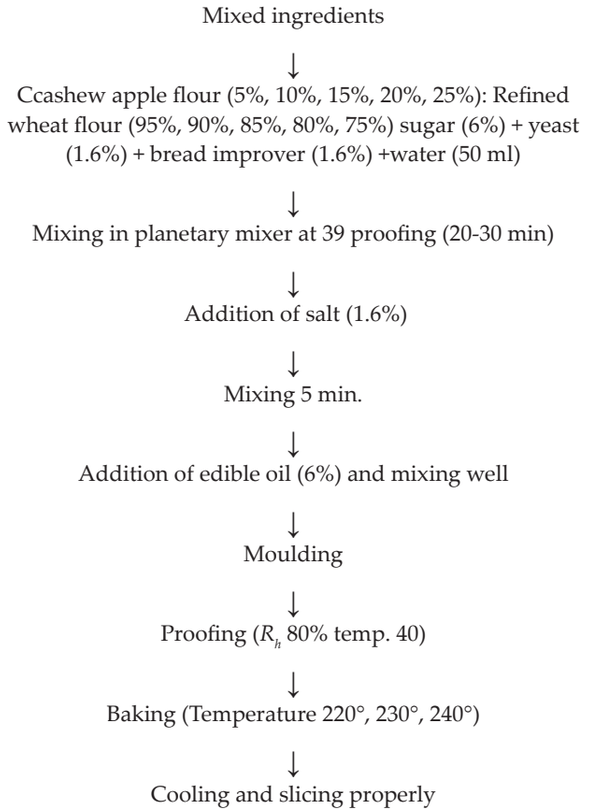


Fig. 1: Process flow chart for preparation of breads from dried cashew apple flour

Evaluation of Quality Parameter for development of muffins from dried cashew apple flour

1. Moisture content (%)

Initial moisture content of the bread sample prepared from dried cashew apple flour composition C1 to C5 and temperature T1 to T3 were determined by AOAC (2010). 5 g of bread sample taken into the moisture box with lid. The initial weight of moisture box was recorded. The sample were exposed to 105°C ± 1°C for 24 hr in a hot air oven (Make M/s: Aditi Associate, Mumbai. Model: ALO-136). The final weight was recorded. The moisture content of sample was determined by equation (1);

$$\text{Moisture content (\% db.)} = \frac{W2-W1}{W3-W1} \times 100 \qquad \ldots(1)$$

Where,

W_1 = Weight of moisture box, g

W_2 = Weight of moisture box + sample g

W_3 = Weight of moisture box + oven dried sample g

2. Fat content (%)

Fat content of bread sample prepared from dried cashew apple flour composition C1 to C5 and temperature T1 to T3 were determined using Solvent extraction in a soxhlet apparatus as described by James, (1995). Two grams of each bread sample wrapped in filter paper and 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. The average reading reported.

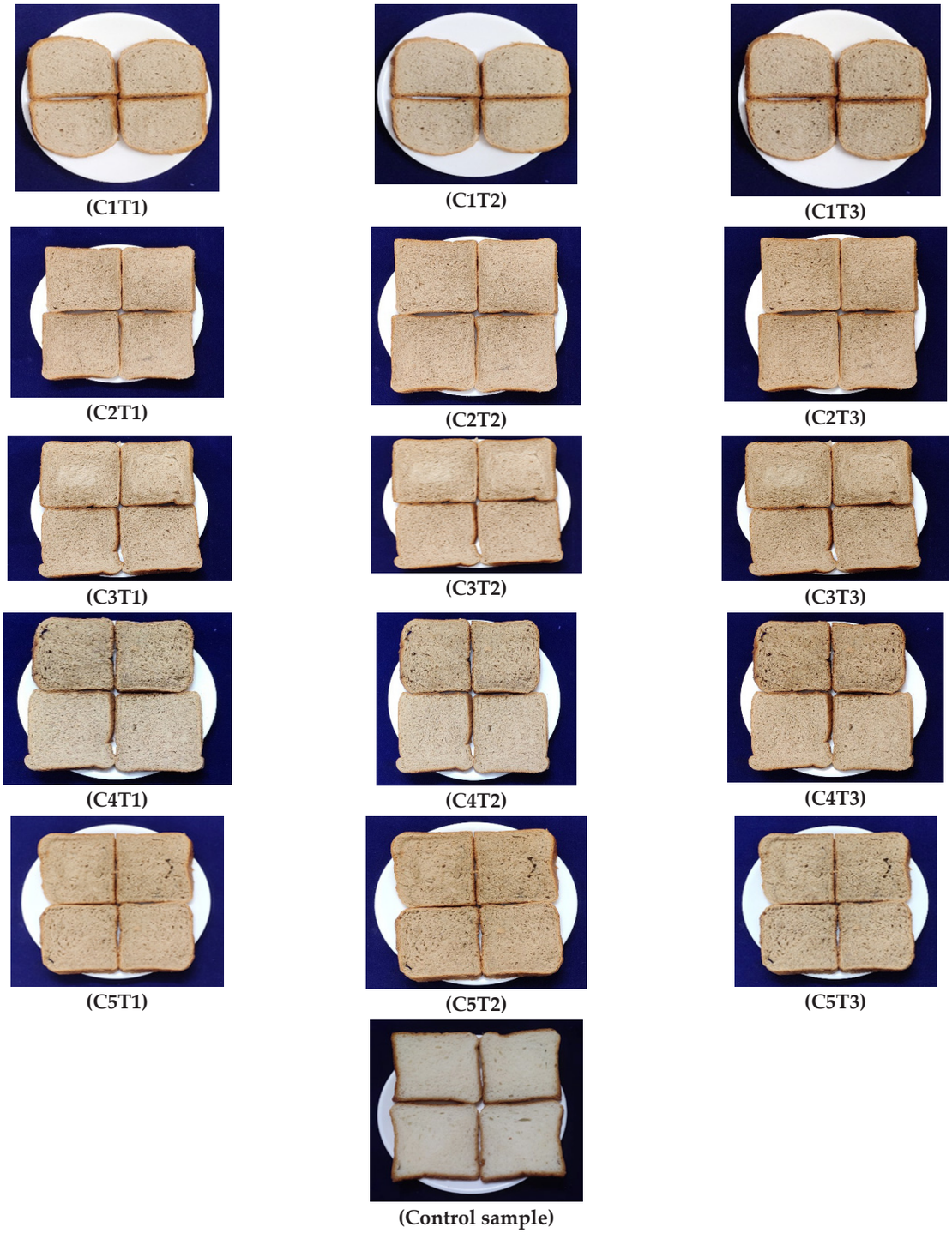


Fig. 2: Dried cashew apple flour breads in various concentrations and different baking temperatures; (C1 = 5% Cashew apple flour; C2 = 10% Cashew apple flour; C3 = 15% Cashew apple flour; C4 = 20% Cashew apple flour, C5 = 25 % Cashew apple flour). T1 = 220°; T2 = 230°; T3 = 240°)

$$\% \text{ Fat} = \frac{W4 - W3}{W2 - W1} \times 100 \quad \ldots(2)$$

Where,

W_1 = Weight of oven dried thimble,

W_2 = Weight of sample used,

W_3 = Weight of round bottom flask,

W_4 = weight of round bottom flask with fat residue.

3. Ash content (%)

The ash content of bread sample prepared from dried cashew apple flour composition C1 to C5 and temperature T1 to T3 were determined using the method of AOAC (1990) porcelain crucible were dried and cooled in desiccators before weighing. Five grams of the bread sample were weighted into the crucible and the weight was taken. The crucible containing the samples were placed into the muffle furnace at 500°. This temperature was maintained for three hours. The muffle furnace was allowed to cool; the crucible was then brought out, cooled and weighted. The ash content was calculated as follows the experiment was repeated for three times for replication the average reading reported.

$$\text{Ash content \%} = \frac{(W2 - W1)}{(Weight\ of\ sample)} \times 100 \quad \ldots(3)$$

Where,

W_2 = Weight of crucible + ash,

W_1 = Weight of empty crucible.

4. Protein content

Protein content of bread sample prepared from dried cashew apple flour composition C1 to C5 and temperature T1 to T3 were determined by a micro-Kjeldahl distillation method (AOAC, 1990). The sample were digested by heating with concentrated sulphuric acid (H_2SO_4) in the presence of digestion mixture, potassium sulphate (K_2SO_4) and copper sulphate ($CuSO_4$). 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 (4);

$$\% \text{ (N)} = 1.4 \times (\text{ml HCL} - \text{ml blank}) \times \text{Conc. of } \frac{HCL}{Weight} \text{ of sample (g)} \quad \ldots(4)$$

$$\% \text{ Protein} = \% \text{ N} \times \text{Factor (6.25).} \quad \ldots(5)$$

5. Crude Fiber (%)

About 2 g fat free residue of bread prepared from dried cashew apple flour composition C1 to C5 and temperature T1 to T3 were sample taken and then transferred to the digestion flask. 200 ml boiling sulphuric acid was added and immediately the flask was connected to condenser. The flask was heated, boiled by frequently rotating for 30 min. and the volume was maintained with hot water. Then filtered through filter cloth in a fluted funnel. The residue was washed on cloth with hot water or potassium sulphate solution. The residue was returned to digestion flask by washing with hot water. 200 ml boiling sodium hydroxide was added and boiled for 30 min. The volume was adjusted with boiling water, filtered through the muslin cloth and the residue free of alkali was washed. The residue was transferred into crucible and washed with 15 ml alcohol and the crucible was dried at 110° for 2 hours. The crucible was cooled in desiccators and weighted the crucible was ignited in the furnace at 550° for 30 min then cooled and weighted. The loss in weight represented the crude fiber reported by Ranganna, (1986). The experiment was repeated three times and average reading was repeated.

$$\text{Crude Fiber (\%)} = \frac{(W1 - w2)}{Weight\ of\ sample\ (g)} \times 100 \quad \ldots(6)$$

Where,

W_1 = Weight of material before ashing (g)

W_2 = Weight of material after ashing (g)

6. Carbohydrate (%)

Carbohydrate content fresh bread sample prepared by dried cashew apple flour composition C1 to C5 and temperature T1 to T3 were determined by a subtracting the total sum of protein, fiber, ash and fat from the product sample James, (1995). The carbohydrate was calculated by using following equation (6);

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

7. Colour

A colour of bread sample prepared from dried cashew apple flour composition C1 to C5 and temperature T1 to T3 measured by (Make: M/s Konika Minolta, Japan; Model Meter CR-400). The colour of bread sample prepared from dried cashew apple flour were measured in dark room. The equipment was calibrated by placing on the white tile. After the calibration is over, the bread prepared from dried cashew apple flour was placed in the petri dish and keeping the colori reader on the top of the product and colour was measured. The colour was measured as per $10°/D_{65}$ (ASTM) standard. It represents *L*, *a* and *b* value. Degree of lightness or darkness of the sample was represented by '*L*' value, redness or greenness by '*a*' and yellowness to blueness by '*b*' value on hunter scale. The experiment was repeated five times and average values are reported. The whiteness index samples were measured in 4 no. replication for each sample to estimate the degree of lightness (*L*), redness/greenness (a), and yellowness/blueness (b) using a colorimeter. Whiteness index was calculated by the following equation (8) of Park, (1994).

$$\text{Whiteness} = [(100-L)]^2 + a^2 + b^2]^{1/2} \quad \ldots(8)$$

Where,

L = lightness (100) to darkness (0)

a = redness (+60) to Greenness (-60)

b = yellowness (+60) to blueness (-60)

Sensory Evaluation

Breads baked at three different temperatures 220 °C, 230 °C and 240 °C were served in plate after cooling at ambient temperature to trained panelists (i.e. students and staff members of Post Graduate Institute of Post harvest Technology and Management Killa Roha, Raigad). The Trained panel of student and staff evaluated the samples at different aspects such as colour, flavour, taste, texture and overall acceptability using 9-point hedonic scale. All samples were blindly coded with alphabets and numbers.

Statistical Analysis

All the analysis reported in this study was performed in triplicate and data obtained is reported as mean ± standard deviation. The data obtained was analysed statistically to determine statistical significance of treatments. Completely Randomized Design (CRD) was used to test the significance of results. The analysis of variance revealed at significance of S.E and C.D. at 5 percent level. The research data was statistically analysed by following method described by Panse and Sukhatme, (1967).

To identify the best treatment for breads, the quality characteristics of breads having crusty and soft with maximum sensory score of colour and appearance, taste, texture and overall acceptability is considered.

RESULTS AND DISCUSSION

Effect of concentrations (%) of Dried Cashew apple flour and baking temperature on Moisture content of Breads

Fig. 3 shows the effect of various concentrations of cashew apple flour (i.e. 5%, 10%, 15%, 20% and 25%) and baking temperatures (i.e. 220°C, 230°C, 240°C) on the moisture content % of dried cashew apple flour breads. The moisture content for breads for all the concentration were range of 31.720±0.03 to 37.841±0.02%. As the concentrations increases, the moisture content increases from 31.720±0.03 to 37.841±0.02%. and baking temperature increases from 220°C to 240°C the moisture content of dried cashew apple flour breads decreases from 37.841±0.02 to

31.720±0.03 % respectively. The moisture content of the control sample was 37.027±0.030 %. As both the dried cashew apple flour (%) and baking temperature (°C) increase the combined effect of these two shows that the moisture content of the breads shows the increasing and decreasing trend.

Table 1 shows the ANOVA for effect of various concentrations (C1=5%, C2=10%, C3=15%, C4=20%, C5=25%) on moisture content % of dried cashew apple flour breads was significant at $p \leq 0.05$. Similarly, the effect of baking temperatures (i.e., T1=220°C, T2=230°C, T3=240°C) on moisture content % of dried cashew apple flour breads has significant at $p \leq 0.05$. The interactive effect of concentrations (%) and temperature (°C) of baking on moisture content % was also significant at $p \leq 0.05$. The moisture content increased when the substituting of refined wheat flour by dried cashew apple flour. This might be due to a higher insoluble dietary fiber of the cashew apple flour which provides high capacity to retain water (Tharshini *et al.* 2018).

Similar result was observed by Salve and Swami, 2024. The bread was prepared from refined wheat flour and cashew apple powder. As the concentration of cashew apple powder increases 5 to 15% the moisture content of the breads increased from 36.74+0.07 to 38.49+0.06%. Similarly, Amandikwa *et al.* 2015 bread was prepared from wheat yam flour. As the concentration of wheat yam flour increases 25 to 75% the moisture content of the bread increased from 26.82 to 38.90%.

Similarly, Sabovics *et al.* 2014 reported the effect of baking temperature 160°C-240 °C on moisture content of breads, as the baking temperature increases from 160°C-240 °C the moisture content of breads decreases from 47.08±0.07% to 42.12±0.03%. According to Badje et al., 2018 bread was prepared from wheat flour with cashew nut flour. As the concentration of cashew nut flour increases 0 to 40% the moisture content of bread increased from 32.24 to 34.50%. Similarly, Tharshini *et al.* 2018 reported that the slice bread prepared from wheat flour, soybean flour and pomegranate peel powder the moisture content of bread increased with increasing pomegranate peel powder from 2 to 6% which was 30.38 to 30.81%. Ndife (2011) reported that slice bread prepared from soybean flour moisture content was 28.5 to 39.5% with increasing of soyflour.

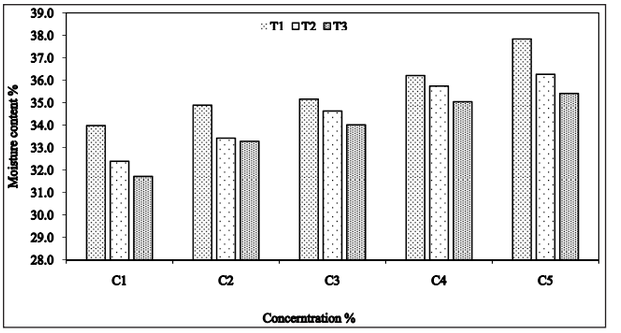


Fig. 3: Effect of concentrations (%) of Dried Cashew apple flour and temperature (°C) on Moisture content of Breads. (C1 = 5 % Cashew apple flour; C2 = 10 % Cashew apple flour; C3 = 15% Cashew apple flour; C4 = 20%Cashew apple flour, C5 = 25 % Cashew apple flour). T1 = 220°; T2 = 230°; T3 = 240°)

Table 1: Effect of concentrations (%) of Dried Cashew apple flour and temperature (°C) on Moisture content of Breads

Concentrations / Temperature	T1	T2	T3	Mean A
C1	33.984 ± 0.01	32.391 ± 0.11	31.720 ± 0.04	32.698
C2	34.892 ± 0.03	33.422 ± 0.09	33.282 ± 0.07	33.865
C3	35.162 ± 0.04	34.633 ± 0.06	34.016 ± 0.08	34.603
C4	36.213 ± 0.09	35.743 ± 0.13	35.043 ± 0.09	35.666
C5	37.841 ± 0.07	36.270 ± 0.07	35.413 ± 0.10	36.508
Mean B	35.618	34.491	33.894	
Control	37.027±0.030			
Factors	**C.D.**		**SE(m)**	
Factor(A)	0.750		0.251	
Factor(B)	0.585		0.195	
Factor (A × B)	1.304		0.435	

Cashew apple flour: Refined Wheat Flour (C1=5:95, C2=10:90, C3=15:85, C4=20:80, C5=25:75) Baking Temperature (T1;220°, T2;230°, T3;240°).

Effect of concentrations (%) of Dried Cashew apple flour and temperature on Protein content of Breads

Fig. 4 shows the effect of various concentrations cashew apple flour (i.e. 5%, 10%, 15%, 20% and 25%) and baking temperatures (i.e. 220°C, 230°C, 240°C) on the protein content % of dried cashew apple flour breads. The protein content for breads for all the concentration were range of 4.070 ±0.09 to 5.950±0.03%. As the concentrations increases, the protein content increases from 4.070 ±0.09 to 5.950±0.03%. and baking temperature increases from 220°C to 240°C the protein content of dried cashew apple flour breads decreases from 5.950±0.03 to 4.070±0.09 % respectively. The protein content of the control sample was 5.89±0.02 %. As both the dried cashew apple flour (%) and baking temperature (°C) increase the combined effect of these two shows that the protein content of the breads shows the increasing and decreasing trend.

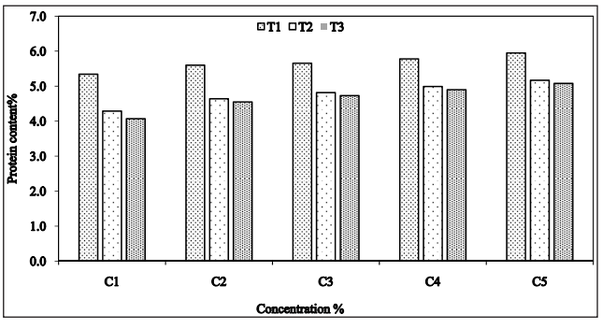


Fig. 4: Effect of concentrations (%) of Dried Cashew apple flour and temperature (°C) on Protein content of Breads. (C1 = 5 % Cashew apple flour; C2 = 10 % Cashew apple flour; C3 = 15% Cashew apple flour; C4 = 20% Cashew apple flour, C5 = 25 % Cashew apple flour). T1 = 220°; T2 = 230°; T3 = 240°)

Table 2 shows the ANOVA for effect of various concentrations (C1=5%, C2=10%, C3=15%, C4=20%, C5=25%) on protein content % of dried cashew apple flour breads was significant at $p \leq 0.05$. Similarly, the effect of baking temperatures (i.e., T1=220°C, T2=230°C, T3=240°C) on protein content % of dried cashew apple flour breads has significant at $p \leq 0.05$. The interactive effect of concentrations (%) and temperature (°C) of baking on protein content % was also significant at $p \leq 0.05$.

Similarly, Hossain *et al.* 2014 bread was prepared from wheat flour with various inclusions of jackfruit flour 0 to 55%. The protein content of the bread increased from 8.25 to 11.35%. Similar result was observed by Adeniji, (2013) bread was prepared from Cassava and wheat flour. As the concentration of cassava powder increases 5 to 20% the protein content of the bread increased from 10.2 to 12.4%.

Table 2: Effect of concentrations (%) of Dried Cashew apple flour and temperature (°C) on Protein content of Breads

Concentrations / Temperature	T1	T2	T3	Mean A
C1	5.343 ± 0.04	4.290 ± 0.09	4.070 ± 0.09	4.567
C2	5.600 ± 0.02	4.640 ± 0.07	4.550 ± 0.05	4.930
C3	5.657 ± 0.06	4.817 ± 0.11	4.730 ± 0.03	5.068
C4	5.780 ± 0.04	4.993 ± 0.04	4.900 ± 0.13	5.224
C5	5.950 ± 0.03	5.170 ± 0.07	5.080 ± 0.04	5.400
Mean B	5.666	4.738	4.710	
Control	5.89±0.02			
Factors	**C.D.**		**SE(m)**	
Factor(A)	0.157		0.054	
Factor(B)	0.126		0.042	
Factor (A × B)	0.282		0.094	

Cashew apple flour: Refined Wheat Flour (C1=5:95, C2=10:90, C3=15:85, C4=20:80, C5=25:75) Baking Temperature (T1;220°, T2;230°, T3;240°)

Similarly, Amandikwa *et al.* 2015 bread was prepared from wheat yam flour. As the concentration of wheat yam flour increases 25 to 75% the protein content of the bread increased from 6.10% to 9.25%. Similar result observed by Ahrne *et al.* 2007 the effect of baking temperature 200 to 260°C on protein content of breads, as the baking temperature increases from 200°C-260°C the protein content of breads decreases from 7.86 to 5.89 %.

Bandal *et al.* 2014 reported that the slice bread prepared from 5% banana peel flour and 5%

Pomegranate peel powder, it is increased protein content of bread was 9.40 to 11% with increasing banana peel flour and pomegranate peel powder. Ndife (2011) reported that slice bread prepared from soybean flour protein content was to 8.13 to 12.5% with increasing of soyflour.

Effect of concentrations (%) of Dried Cashew apple flour and temperature (°C) on fat content of Breads

Fig. 5 shows the effect of various concentrations cashew apple flour (i.e. 5%, 10%, 15%, 20% and 25%) and baking temperatures (i.e. 220°C, 230°C, 240°C) on the fat content % of dried cashew apple flour breads. The fat content for breads for all the concentration were range of 1.660±0.03% to 2.320±0.07 %. As the concentrations increases, the fat content increases 1.660±0.03% to 2.320±0.07 %. and baking temperature increases from 220°C to 240°C the fat content of dried cashew apple flour breads decreases from 2.320±0.07 to 1.660±0.03% respectively. The fat content of the control sample was 2.12±0.006 %. As both the dried cashew apple flour (%) and baking temperature (°C) increase the combined effect of these two shows that the fat content of the breads shows the increasing and decreasing trend.

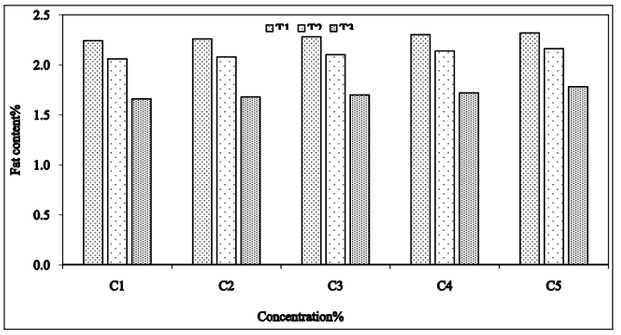


Fig. 5: Effect of concentrations (%) of Dried Cashew apple flour and temperature (°C) on fat content of Breads. (C1 = 5 % Cashew apple flour; C2 = 10 % Cashew apple flour; C3 = 15% Cashew apple flour; C4 = 20% Cashew apple flour, C5 = 25 % Cashew apple flour). T1 = 220°; T2 = 230°; T3 = 240°)

Table 3 shows the ANOVA for effect of various concentrations (C1=5%, C2=10%, C3=15%, C4=20%, C5=25%) on fat content % of dried cashew apple flour breads was significant at $p \leq 0.05$. Similarly, the effect of baking temperatures (i.e., T1=220°C, T2=230°C, T3=240°C) on fat content % of dried cashew apple flour breads has significant at $p \leq 0.05$. The interactive effect of concentrations (%) and temperature (°C) of baking on fat content % was also significant at $p \leq 0.05$.

Table 3: Effect of concentrations (%) of Dried Cashew apple flour and temperature (°C) on Fat content of Breads

Concentrations / Temperature	T1	T2	T3	Mean A
C1	2.243 ± 0.03	2.060 ± 0.07	1.660 ± 0.03	1.987
C2	2.260 ± 0.01	2.080 ± 0.09	1.680 ± 0.07	2.006
C3	2.281 ± 0.07	2.103 ± 0.06	1.700 ± 0.08	2.028
C4	2.302 ± 0.09	2.140 ± 0.03	1.720 ± 0.05	2.054
C5	2.320 ± 0.07	2.163 ± 0.01	1.782 ± 0.10	2.088
Mean B	2.281	2.109	1.708	
Control	2.12±0.006			
Factors	**C.D.**		**SE(m)**	
Factor(A)	0.027		0.009	
Factor(B)	0.021		0.007	
Factor (A × B)	0.047		0.016	

Cashew apple flour: Refined Wheat Flour (C1=5:95, C2=10:90, C3=15:85, C4=20:80, C5=25:75) Baking Temperature (T1;220°, T2;230°, T3;240°)

Similarly, Menon *et al.* 2014 observed that the bread prepared from mango kernel flour and soy flour. As the concentration of mango kernel flour increases 5 to 15% the fat content of the bread increased from 8 to 16 %. Because Mango kernel flour had already been identified as a high crude fat source. According to Selimovic *et al.* 2014 reported that the bread prepared from buckwheat flour. As the concentration of buckwheat flour increases from 15 to 40%. The fat content of bread increased from 1.23 to 1.62%. Result shows that the buckwheat bread contain mineral and fat higher than wheat flour.

Similar result observed by Shittu *et al.* 2006 the effect of baking temperature 190 to 240°C on fat content of breads, as the baking temperature increases from 190°C-240°C the fat content of breads decreases from 3.86 to 1.89 %. Similarly, Amandikwa *et al.* 2015 bread was prepared from wheat yam flour. As the concentration of wheat yam flour increases 25 to 75% the fat content of the bread increased from 6.10% to 9.25 %. Ndife (2011) reported that slice bread prepared from soybean flour fat content was to 4.0 to 6.4 % with increasing of soyflour.

Effect of concentrations (%) of Dried Cashew apple flour and temperature (°C) on ash content of Breads.

Fig. 6 shows the effect of various concentrations of cashew apple flour (i.e. 5%, 10%, 15%, 20% and 25%) and baking temperatures (i.e. 220°C, 230°C, 240°C) on the ash content % of dried cashew apple flour breads. The ash content for breads for all the concentration were range of 0.244±0.08 to 0.508±0.09 %. As the concentrations increases, the ash content increases from 0.244±0.08 to 0.508±0.09 %. and baking temperature increases from 220°C to 240°C the ash content of dried cashew apple flour breads decreases from 0.508±0.09 to 0.244±0.08 % respectively. The ash content of the control sample was 0.290±0.11%. As both the dried cashew apple flour (%) and baking temperature (°C) increase the combined effect of these two shows that the ash content of the breads shows the increasing and decreasing trend.

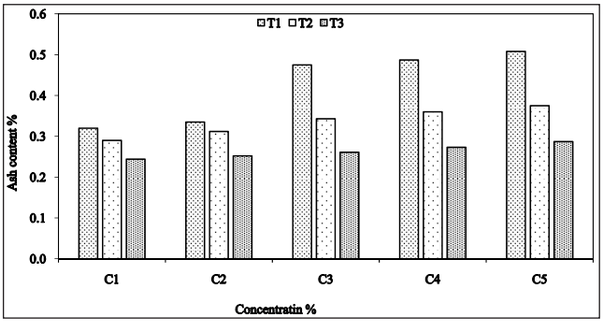


Fig. 6: Effect of concentrations (%) of Dried Cashew apple flour and temperature on Ash content of Breads. (C1= 5 %Cashew apple flour; C2=10 %Cashew apple flour; C3 = 15%Cashew apple flour; C4 = 20%Cashew apple flour, C5 = 25 %Cashew apple flour). T1 = 220°; T2 = 230°; T3 = 240°)

Table 4: Effect of concentrations (%) of Dried Cashew apple flour and temperature (°C) on Ash content of Breads

Concentrations / Temperature	T1	T2	T3	Mean A
C1	0.320 ± 0.01	0.290 ± 0.07	0.244 ± 0.08	0.284
C2	0.335 ± 0.05	0.312 ± 0.09	0.252 ± 0.01	0.299
C3	0.475 ± 0.07	0.343 ± 0.11	0.261 ± 0.06	0.359
C4	0.487 ± 0.02	0.360 ± 0.07	0.273 ± 0.15	0.373
C5	0.508 ± 0.09	0.375 ± 0.03	0.287 ± 0.09	0.390
Mean B	0.425	0.336	0.263	
Control	0.290±0.11			
Factors	C.D.		SE(m)	
Factor(A)	0.027		0.009	
Factor(B)	0.021		0.007	
Factor (A × B)	0.047		0.016	

Cashew apple flour: Refined Wheat Flour (C1=5:95, C2=10:90, C3=15:85, C4=20:80, C5=25:75) Baking Temperature (T1;220°, T2;230°, T3;240°)

Table 4 shows the ANOVA for effect of various concentrations (C1=5%, C2=10%, C3=15%, C4=20%, C5=25%) on ash content % of dried cashew apple flour breads was significant at $p \leq 0.05$. Similarly, the effect of baking temperatures (i.e., T1=220°C, T2=230°C, T3=240°C) on ash content % of dried cashew apple flour breads has significant at $p \leq 0.05$. The interactive effect of concentrations (%) and temperature (°C) of baking on ash content % was also significant at $p \leq 0.05$.

Similar result was observed by Salve and Swami, 2024. The bread was prepared from refined wheat flour and cashew apple powder. As the concentration of cashew apple powder increases 5 to 15% the ash content of the breads increased from 1.04±0.06% to 1.35±0.03%. Similarly, Hossain *et al.* 2014 bread was prepared from jackfruit seed flour. The jackfruit seed flour increases inclusion of 0 to 55%. The ash content of the bread increased from 1.5 to 2.10%.

According to Selimovic *et al.* 2014 reported that the bread prepared from buckwheat flour. As the concentration of buckwheat flour increases from 15 to 40%. The ash content of bread increased from 0.49% and 2.4%. Similarly, Amandikwa *et al.* 2015 bread was prepared from wheat yam flour. As the concentration of wheat yam flour increases 25 to 75% the ash content of the bread increased from 1.90 to 2.45%.

Similar result observed by Shittu *et al.* 2006 the effect of baking temperature 190 to 240°C on ash content of breads, as the baking temperature increases from 190°C-240°C the ash content of breads decreases from 2.76 to 0.89 %. Bandal *et al.* 2014 reported that the slice bread prepared from 5% banana peel flour and 5% Pomegranate peel powder, it is increased ash content of bread was 1.07 to 2.3% with increasing banana peel flour and pomegranate peel powder. Ndife (2011) reported that slice bread prepared from soybean flour ash content was to 1.82 to 2.65 % with increasing of soyflour.

Effect of concentrations (%) of Dried Cashew apple flour and temperature on fiber content of Breads

Fig. 7 shows the effect of various concentrations of cashew apple flour (i.e. 5%, 10%, 15%, 20% and 25%) and baking temperatures (i.e. 220°C, 230°C, 240°C) on the fiber content % of dried cashew apple flour breads.

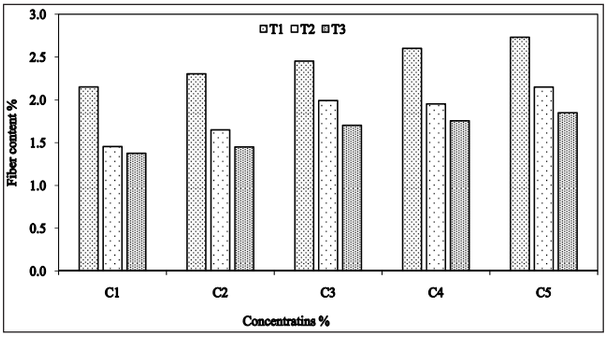


Fig. 7: Effect of concentrations (%) of Dried Cashew apple flour and temperature (°C) on Fiber content of Breads. (C1= 5 %Cashew apple flour; C2=10 %Cashew apple flour; C3= 15%Cashew apple flour; C4=20%Cashew apple flour, C5=25 %Cashew apple flour). T1= 220°; T2=230°; T3= 240°)

The fiber content for breads for all the concentration were range of 0.950±0.01 to 3.732±0.04 %. As the concentrations increases, the fiber content increases and baking temperature increases from 220°C to 240°C the fiber content of dried cashew apple flour breads decreases from 3.732±0.04 to 0.950±0.01 % respectively. The fiber content of the control sample was 2.90±0.05%. As both the dried cashew apple flour (%) and baking temperature (°C) increase the combined effect of these two shows that the fiber content of the breads shows the increasing and decreasing trend.

Table 5 shows the ANOVA for effect of various concentrations (C1=5%, C2=10%, C3=15%, C4=20%, C5=25%) on fiber content % of dried cashew apple flour breads was significant at $p \leq 0.05$. Similarly, the effect of baking temperatures (i.e., T1=220°C, T2=230°C, T3=240°C) on fiber content % of dried cashew apple flour breads has significant at $p \leq 0.05$. The interactive effect of concentrations (%) and temperature (°C) of baking on fiber content % was also significant at $p \leq 0.05$.

Similarly, Hossain *et al.* 2014 bread was prepared from jackfruit seed flour. The jackfruit seed flour increases inclusion of 0 to 55%. The fiber content of the bread increased from 2.0 to 4.09%. Similarly, Amandikwa *et al.* 2015 bread was prepared from wheat yam flour. As the concentration of wheat yam flour increases 25 to 75% the fiber content of the bread increased from 0.12% to 0.64%.

Similar result observed by Ahrne *et al.* 2007 the effect of baking temperature 200 to 260°C on fiber content of breads, as the baking temperature increases from 200°C-260°C the fiber content of breads decreases from 3.56 to 1.13 %. Similar result observed by Shittu *et al.* 2006 the effect of baking temperature 190 to 240°C on fiber content of breads, as the baking temperature increases from 190°C-240°C the fiber content of breads decreases from 3.73 to 1.04 %. Ndife (2011) reported that slice bread prepared from soybean flour fiber content was to 1.45 to 2.89 % with increasing of soyflour.

Table 5: Effect of concentrations (%) of Dried Cashew apple flour and temperature (°C) on Fiber content of Breads

Concentrations / Temperature	T1	T2	T3	Mean A
C1	2.151 ± 0.04	1.455 ± 0.07	0.950 ± 0.01	1.660
C2	2.305 ± 0.11	1.650 ± 0.13	1.450 ± 0.07	1.801
C3	2.453 ± 0.04	1.992 ± 0.09	1.703 ± 0.12	2.049
C4	2.602 ± 0.07	1.953 ± 0.06	1.750 ± 0.08	2.103
C5	3.732 ± 0.04	2.150 ± 0.03	1.850 ± 0.06	2.244
Mean B	2.448	1.840	1.627	
Control	2.90±0.05			
Factors	**C.D.**		**SE(m)**	
Factor(A)	0.033		0.011	
Factor(B)	0.024		0.008	
Factor (A × B)	0.054		0.019	

Cashew apple flour: Refined Wheat Flour (C1=5:95, C2=10:90, C3=15:85, C4=20:80, C5=25:75) Baking Temperature (T1;220°, T2;230°, T3;240°)

Effect of concentrations (%) of Dried Cashew apple flour and temperature (°C) on carbohydrate content of Breads.

Fig. 8 shows the effect of various concentrations of cashew apple flour (i.e. 5%, 10%, 15%, 20% and 25%) and baking temperatures (i.e. 220°C, 230°C, 240°C) on the carbohydrate content % of dried cashew apple flour breads. The carbohydrate content for breads for all the concentration were range of 50.423±0.03% to 73.213±0.15%. As the concentrations increases, the carbohydrate content increases from 50.423±0.03% to 73.213±0.15%. and baking temperature increases from 220°C to 240°C the carbohydrate content of dried cashew apple flour breads decreases from 73.213±0.15% to 50.423±0.03 respectively. The carbohydrate content of the control sample was 51.840±0.04 %. As both the dried cashew apple flour (%) and baking temperature (°C) increase the combined effect of these two shows that the carbohydrate content of the breads shows the increasing and decreasing trend.

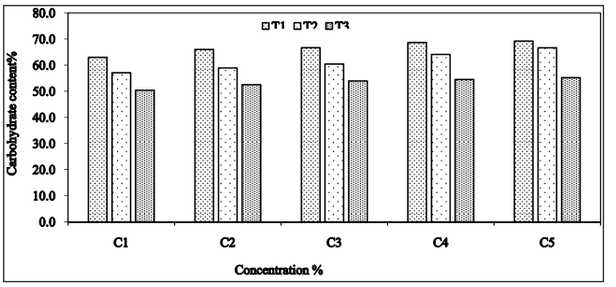


Fig. 8: Effect of concentrations (%) of Dried Cashew apple flour and temperature (°C) on Carbohydrate content of Breads. (C1= 5 %Cashew apple flour; C2 = 10 %Cashew apple flour; C3 = 15%Cashew apple flour; C4 = 20% Cashew apple flour, C5 = 25 % Cashew apple flour). T1 = 220°; T2 = 230°; T3 = 240°)

Table 6 shows the ANOVA for effect of various concentrations (C1=5%, C2=10%, C3=15%, C4=20%, C5=25%) on carbohydrate content % of dried cashew apple flour breads was significant at $p \leq 0.05$. Similarly, the effect of baking temperatures (i.e., T1=220°C, T2=230°C, T3=240°C) on carbohydrate content % of dried cashew apple flour breads has significant at $p \leq 0.05$. The interactive effect of concentrations (%) and temperature (°C) of baking on carbohydrate content % was also significant at $p \leq 0.05$.

According to Selimovic *et al.* 2014 reported that the bread prepared from buckwheat flour. As the concentration of buckwheat flour increases from 15 to 40%. The carbohydrate content of bread increased from 55.13 to 67.56 %. Similar result observed by Shittu *et al.* 2006 the effect of baking temperature 190 to 240°C on carbohydrate content of breads, as the baking temperature increases from 190°C-240°C the carbohydrate content of breads decreases from 69.34 to 53.11%.

Similarly, Urigacha, (2020) the effect of baking temperature 190°C-240°C, as the baking temperature increases from 190°C-240°C the carbohydrate content of breads decreases from 57.55 to 47.68%.

Table 6: Effect of concentrations (%) of Dried Cashew apple flour and temperature (°C) on Carbohydrate content of Breads

Concentrations / Temperature	T1	T2	T3	Mean A
C1	63.003 ± 0.02	57.100 ± 0.04	50.423 ± 0.03	56.842
C2	66.013 ± 0.15	58.920 ± 0.03	52.520 ± 0.12	59.151
C3	66.680 ± 0.05	60.430 ± 0.02	53.940 ± 0.03	60.350
C4	68.670 ± 0.04	64.111 ± 0.11	54.530 ± 0.07	62.437
C5	69.213 ± 0.15	66.640 ± 0.03	55.213 ± 0.07	62.688
Mean B	66.715	61.400	53.325	
Control	51.840±0.04			
Factors	**C.D.**		**SE(m)**	
Factor(A)	0.162		0.054	
Factor(B)	0.126		0.042	
Factor (A × B)	0.282		0.094	

Cashew apple flour: Refined Wheat Flour (C1=5:95, C2=10:90, C3=15:85, C4=20:80, C5=25:75) Baking Temperature (T1;220°, T2;230°, T3;240°)

Effect of concentrations (%) of Dried Cashew apple flour and temperature (°C) on Whiteness index of Breads

Fig. 9 shows the effect of various concentrations of cashew apple flour (i.e. 5%, 10%, 15%, 20% and 25%) and baking temperatures (i.e. 220°C, 230°C, 240°C) on the whitening index % of dried cashew apple flour breads. The whitening index for breads for all the concentration were range of 28.13 to 40.66 %. As the concentrations increases, the WI decreases. and baking temperature increases from 220°C to 240°C the WI content of dried cashew apple flour breads decreases from 40.66 to 28.13% to respectively. The whitening index of the control sample was 32.72±0.07%. As both the dried cashew apple flour (%) and baking temperature (°C) increase the combined effect of these two shows that the WI content of the breads shows the decreasing trend.

Table 7 shows the ANOVA for effect of various concentrations (C1=5%, C2=10%, C3=15%, C4=20%, C5=25%) on BI % of dried cashew apple flour breads was significant at $p \leq 0.05$. Similarly, the effect of baking temperatures (i.e., T1=220°C, T2=230°C, T3=240°C) on carbohydrate content % of dried cashew apple flour breads has significant at $p \leq 0.05$. The interactive effect of concentrations (%) and temperature (°C) of baking on WI % was also significant at $p \leq 0.05$. The Whitening index increased when the substituting of refined wheat flour by dried cashew apple flour. This might be due to the interactive effect of both the effect of different concentrations and different temperature used for breads making indicated that the whiteness index shows the decreasing trend.

According to Selimovic *et al.* 2014 reported that the bread prepared from buckwheat flour. As the concentration of buckwheat flour increases from 15 to 40%. The WI of bread decreased from 66.56 to 52.11 %. According to Badaje et al., 2018 bread was prepared from defatted cashew kernel flour. Cashew kernel flour increases from 10 to 40%. The whitening index of the bread was gradually decreased.

Similarly, Urigacha, (2020) the effect of baking temperature 190°C-240°C, as the baking temperature increases from 190°C-240°C the whitening index of breads decreases from 76.34 to 65.12%.

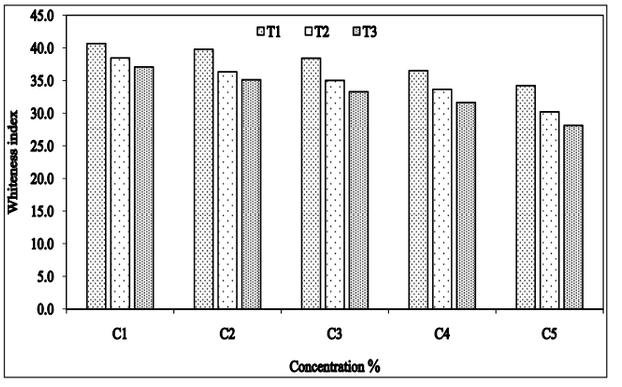


Fig. 9: Effect of concentrations (%) of Dried Cashew apple flour and temperature (°C) on Whiteness index of Bread. (C1 = 5 % Cashew apple flour; C2 = 10 % Cashew apple flour; C3 = 15% Cashew apple flour; C4 = 20% Cashew apple flour, C5 = 25 % Cashew apple flour). T1 = 220°; T2 = 230°; T3 = 240°)

Table 7: Effect of concentrations (%) of Dried Cashew apple flour and temperature (°C) on Whiteness index of Breads

Concentrations / Temperature	T1	T2	T3	Mean A
C1	40.66 ± 0.03	38.47 ± 0.01	37.09 ± 0.06	38.74
C2	39.79 ± 0.07	36.34 ± 0.04	35.13 ± 0.02	37.08
C3	38.42 ± 0.09	35.03 ± 0.02	33.28 ± 0.01	35.57
C4	36.52 ± 0.11	33.66 ± 0.07	31.64 ± 0.12	33.94
C5	34.23 ± 0.03	30.21 ± 0.12	28.13 ± 0.09	30.85
Control	32.72±0.07			
Mean B	37.92	34.74	27.43	
Factors	**C.D.**		**SE(m)**	
Factor(A)	0.090		0.030	
Factor(B)	0.069		0.023	
Factor (A × B)	0.195		0.065	

Cashew apple flour: Refined Wheat Flour (C1=5:95, C2=10:90, C3=15:85, C4=20:80, C5=25:75) Baking Temperature (T1;220°, T2;230°, T3;240°)

Effect of concentrations (%) of Dried Cashew apple flour and temperature (°C) on sensory Colour of breads

Fig.10 shows the effect of various concentrations of cashew apple flour (i.e., 5%, 10%, 20%, 15%, 25%) and baking temperatures (i.e. 220°C, 230°C, 240°C) on the sensory colour of dried cashew apple flour breads. It was observed that the range of sensory colour for all concentrations and baking temperatures was from 6.720±0.11 to 8.780±0.19.

Table 8 shows that the ANOVA for colour of sensory analysis. Highest colour score was observed at C1T2 i.e. 8.78 and lowest was observed at C3T1 i.e. 6.72. Control sample bread was sensory colour score 8.02±0.12 From all five concentrations and three baking temperatures, Treatment C1T2 gives higher sensory score. The effect of dried cashew apple flour concentrations (%) shows the significant effect $p \leq 0.05$. Similarly, baking temperature (°C) has significant effect $p \leq 0.05$ on the colour of breads. The combined effect of dried cashew apple flour (%) and baking temperature (°C) has significant effect $p \leq 0.05$ on the colour of bread sample.

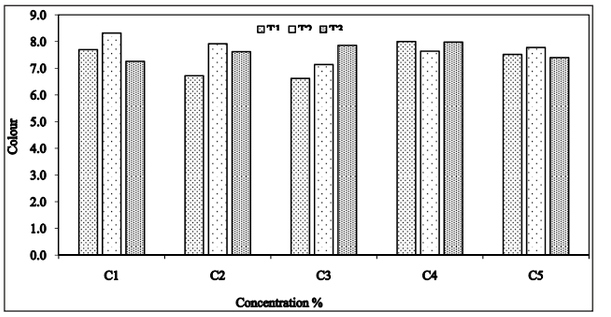


Fig. 10: Effect of concentrations (%) of Dried Cashew apple flour and temperature (°C) on sensory Colour of Breads. C1 = 5 % Cashew apple flour; C2 = 10 % Cashew apple flour; C3 = 15% Cashew apple flour; C4 = 20% Cashew apple flour, C5 = 25 % Cashew apple flour). T1 = 220°; T2 = 230°; T3 = 240°)

Table 8: Effect of concentrations (%) of Dried Cashew apple flour and temperature (°C) on sensory Colour of Breads

Concentrations / Temperature	T1	T2	T3	Mean A
C1	7.800 ± 0.10	8.780 ± 0.19	8.120 ± 0.11	8.233
C2	7.740 ± 0.10	7.940 ± 0.10	7.520 ± 0.07	7.733
C3	6.720 ± 0.11	7.300 ± 0.14	7.120 ± 0.11	7.047
C4	6.680 ± 0.12	7.640 ± 0.13	7.260 ± 0.19	7.193
C5	7.820 ± 0.07	6.780 ± 0.07	7.180 ± 0.19	7.260
Control	8.02±0.12			
Mean B	7.352	7.688	7.440	
Factors	**C.D.**		**SE(m)**	
Factor(A)	0.087		0.030	
Factor(B)	0.069		0.023	
Factor (A × B)	0.195		0.065	

Cashew apple flour: Refined Wheat Flour (C1=5:95, C2=10:90, C3=15:85, C4=20:80, C5=25:75) Baking Temperature (T1;220°, T2;230°, T3;240°).

Effect of concentrations (%) of Dried Cashew apple flour and temperature (°C) on sensory Taste of Breads

Fig. 11 shows the effect of various concentrations of cashew apple flour (i.e., 5%, 10%, 20%, 15%, 25%) and baking temperatures (i.e. 220°C, 230°C, 240°C) on the sensory taste of dried cashew apple flour breads. It was observed that the range of sensory taste for all concentrations and baking temperatures was from 6.620±0.11 to 8.320±0.07.

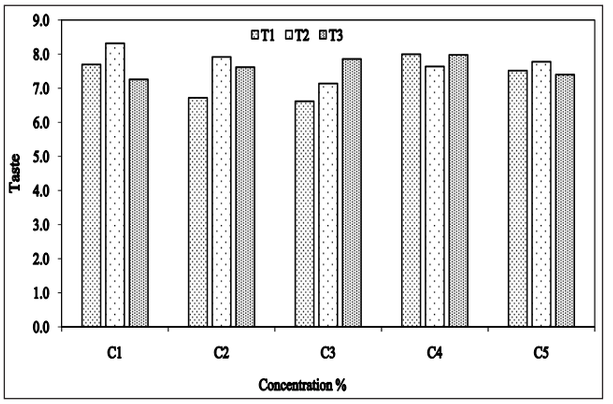


Fig. 11: Effect of concentrations (%) of Dried Cashew apple flour and temperature (°C) on sensory taste of Breads. C1 = 5 % Cashew apple flour; C2 = 10 % Cashew apple flour; C3 = 15% Cashew apple flour; C4 = 20% Cashew apple flour, C5 = 25 % Cashew apple flour). T1 = 220°; T2 = 230°; T3 = 240°)

Table 9: Effect of concentrations (%) of Dried Cashew apple flour and temperature (°C) on sensory Taste of Breads

Concentrations / Temperature	T1	T2	T3	Mean A
C1	7.700 ± 0.08	8.320 ± 0.07	7.260 ± 0.10	7.760
C2	6.720 ± 0.11	7.920 ± 0.19	7.620 ± 0.11	7.420
C3	6.620 ± 0.11	7.140 ± 0.13	7.860 ± 0.10	7.207
C4	8.000 ± 0.06	7.640 ± 0.13	7.980 ± 0.07	7.873
C5	7.520 ± 0.19	7.780 ± 0.11	7.400 ± 0.10	7.567
Control	8.200±0.08			
Mean B	7.312	7.760	7.624	

Factors	C.D.	SE(m)
Factor(A)	0.105	0.035
Factor(B)	0.081	0.027
Factor (A × B)	0.153	0.051

Cashew apple flour: Refined Wheat Flour (C1=5:95, C2=10:90, C3=15:85, C4=20:80, C5=25:75) Baking Temperature (T1;220°, T2;230°, T3;240°)

Table 9 shows that the ANOVA for taste of sensory analysis. Highest taste score was observed at C1T2 i.e.8.32 and lowest was observed at C3T1 i.e. 6.62. Control sample bread was sensory taste score 8.200±0.08. From all five concentrations and three baking temperatures, Treatment C1T2 gives higher sensory score. The effect of dried cashew apple flour concentrations (%) shows the significant effect $p \leq 0.05$. Similarly, baking temperature (°C) has significant effect $p \leq 0.05$ on the taste of breads. The combined effect of dried cashew apple flour (%) and baking temperature (°C) has significant effect $p \leq 0.05$ on the taste of bread sample.

Effect of concentrations (%) of Dried Cashew apple flour and temperature (°C) on sensory flavour of Breads

Fig. 12 shows the effect of various concentrations of cashew apple flour (i.e., 5%, 10%, 20%, 15%, 25%) and baking temperatures (i.e. 220°C, 230°C, 240°C) on the sensory flavour of dried cashew apple flour breads. It was observed that the range of sensory flavour for all concentrations and baking temperatures was from 6.600±0.10 to 8.480±0.12.

Table 10 shows that the ANOVA for flavour of sensory analysis. Highest taste score was observed at C1T2 i.e.8.48 and lowest was observed at C5T3 i.e.6.60. Control sample bread was sensory flavour score 8.260±0.10. From all five concentrations and three baking temperatures, Treatment C1T2 gives higher sensory score. The effect of dried cashew apple flour concentrations (%) shows the significant effect $p \leq 0.05$. Similarly, baking temperature (°C) has significant effect $p \leq 0.05$ on the flavour of breads. The combined effect of dried cashew apple flour (%) and baking temperature (°C) has significant effect $p \leq 0.05$ on the flavour of bread sample.

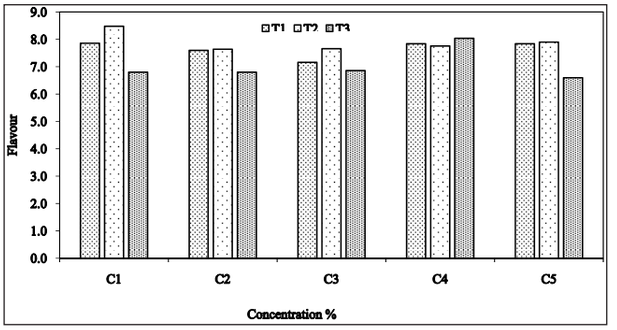


Fig. 12: Effect of concentrations (%) of Dried Cashew apple flour and temperature(°C) on sensory flavour of Breads. C1 = 5 % Cashew apple flour; C2 = 10 % Cashew apple flour; C3 = 15% Cashew apple flour; C4 = 20% Cashew apple flour, C5 = 25 % Cashew apple flour). T1 = 220°; T2 = 230°; T3 = 240°)

Table 10: Effect of concentrations (%) of Dried Cashew apple flour and temperature (°C) on sensory flavour of Breads

Concentrations / Temperature	T1	T2	T3	Mean A
C1	7.860 ± 0.13	8.480 ± 0.12	6.800 ± 0.06	7.713
C2	7.600 ± 0.14	7.640 ± 0.10	6.750 ± 0.08	7.347
C3	7.160 ± 0.10	7.660 ± 0.11	6.860 ± 0.12	7.227
C4	7.840 ± 0.12	7.760 ± 0.10	8.040 ± 0.11	7.880
C5	7.740 ± 0.08	7.900 ± 0.07	6.600 ± 0.10	7.413
Control	8.260±0.10			
Mean B	7.640	7.888	7.010	
Factors	**C.D.**		**SE(m)**	
Factor(A)	0.093		0.031	
Factor(B)	0.069		0.024	
Factor (A × B)	0.162		0.054	

Cashew apple flour: Refined Wheat Flour (C1=5:95, C2=10:90, C3=15:85, C4=20:80, C5=25:75) Baking Temperature (T1;220°, T2;230°, T3;240°)

Effect of concentrations (%) of Dried Cashew apple flour and temperature (°C) on sensory texture of Breads

Fig. 13 shows the effect of various concentrations of cashew apple flour (i.e., 5%, 10%, 20%, 15%, 25%) and baking temperatures (i.e. 220°C, 230°C, 240°C) on the sensory texture of dried cashew apple flour breads. It was observed that the range of sensory texture for all concentrations and baking temperatures was from 6.400±0.09 to 8.460±0.11.

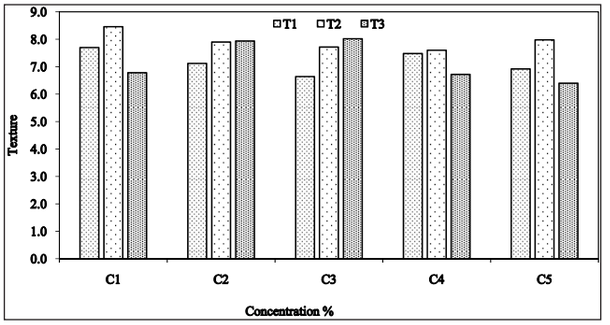


Fig. 13: Effect of concentrations (%) of Dried Cashew apple flour and temperature (°C) on sensory texture of Breads. C1 = 5 % Cashew apple flour; C2 = 10 % Cashew apple flour; C3 = 15% Cashew apple flour; C4 = 20% Cashew apple flour, C5 = 25 % Cashew apple flour). T1 = 220°; T2 = 230°; T3 = 240°)

Table 11: Effect of concentrations (%) of Dried Cashew apple flour and temperature (°C) on sensory texture of Breads

Concentrations / Temperature	T1	T2	T3	Mean A
C1	7.700 ± 0.10	8.460 ± 0.11	6.780 ± 0.07	7.647
C2	7.120 ± 0.08	7.900 ± 0.08	7.940 ± 0.10	7.653
C3	6.640 ± 0.10	7.720 ± 0.18	8.020 ± 0.07	7.460
C4	7.480 ± 0.07	7.600 ± 0.21	6.720 ± 0.11	7.267
C5	6.920 ± 0.07	7.980 ± 0.08	6.400 ± 0.09	7.100
Control	8.120±0.11			
Mean B	7.172	7.932	7.172	
Factors	**C.D.**		**SE(m)**	
Factor(A)	0.092		0.032	
Factor(B)	0.071		0.025	
Factor (A × B)	0.168		0.056	

Cashew apple flour: Refined Wheat Flour (C1=5:95, C2=10:90, C3=15:85, C4=20:80, C5=25:75) Baking Temperature (T1;220°, T2;230°, T3;240°).

Table 11 shows that the ANOVA for texture of sensory analysis. Highest texture score was observed at C1T2 i.e.8.46 and lowest was observed at C5T3 i.e.6.40. Control sample bread was sensory texture score 8.120±0.11. From all five concentrations and three baking temperatures, Treatment C1T2 gives higher sensory score. The effect of dried cashew apple flour concentrations (%) shows the significant effect $p \leq 0.05$. Similarly, baking temperature (°C) has significant effect $p \leq 0.05$ on the texture of breads. The combined effect of dried cashew apple flour (%) and baking temperature (°C) has significant effect $p \leq 0.05$ on the texture of bread sample.

Effect of concentrations (%) of Dried Cashew apple flour and temperature (°C) on sensory overall acceptability of breads

Fig. 14 shows the effect of various concentrations of cashew apple flour (i.e., 5%, 10%, 20%, 15%, 25%) and baking temperatures (i.e. 220°C, 230°C, 240°C) on the sensory overall acceptability of dried cashew apple flour breads. It was observed that the range of sensory overall acceptability for all concentrations and baking temperatures was from 6.720±0.11 to 8.520±0.13.

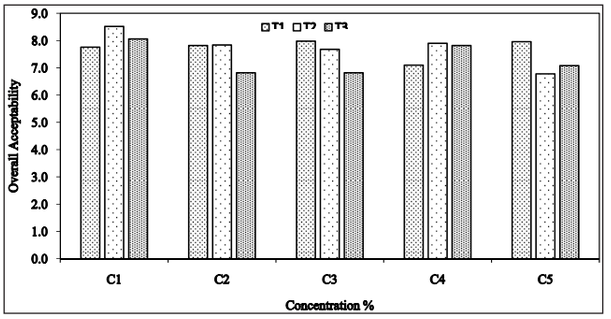


Fig. 14: Effect of concentrations (%) of Dried Cashew apple flour and temperature (°C) on sensory overall acceptability of Breads. C1 = 5 % Cashew apple flour; C2 = 10 % Cashew apple flour; C3 = 15% Cashew apple flour; C4 = 20% Cashew apple flour, C5 = 25 % Cashew apple flour). T1 = 220°; T2 = 230°; T3 = 240°)

Table 12 shows that the ANOVA for overall acceptability of sensory analysis. Highest overall acceptability score was observed at C1T2 i.e.8.52 and lowest was observed at C5T3 i.e.6.72. Control sample bread was sensory overall acceptability score 8.400±0.08. From all five concentrations and three baking temperatures, Treatment C1T2 gives higher sensory score. The effect of dried cashew apple flour concentrations (%) shows the significant effect $p \leq 0.05$. Similarly, baking temperature (°C) has significant effect $p \leq 0.05$ on the overall acceptability of breads. The combined effect of dried cashew apple flour (%) and baking temperature (°C) has significant effect $p \leq 0.05$ on the overall acceptability of bread sample.

Table 12: Effect of concentrations (%) of Dried Cashew apple flour and temperature (°C) on sensory overall acceptability of Breads

Concentrations / Temperature	T1	T2	T3	Mean A
C1	7.760 ± 0.10	8.520 ± 0.13	8.060 ± 0.12	8.113
C2	7.820 ± 0.07	7.840 ± 0.10	6.820 ± 0.07	7.493
C3	7.980 ± 0.08	7.680 ± 0.16	6.720 ± 0.11	7.460
C4	7.100 ± 0.08	7.900 ± 0.09	7.820 ± 0.11	7.607
C5	7.960 ± 0.04	6.780 ± 0.11	7.080 ± 0.07	7.273
Control	8.400±0.08			
Mean B	7.724	7.744	7.3	
Factors	**C.D.**		**SE(m)**	
Factor(A)	0.090		0.030	
Factor(B)	0.069		0.023	
Factor (A × B)	0.156		0.052	

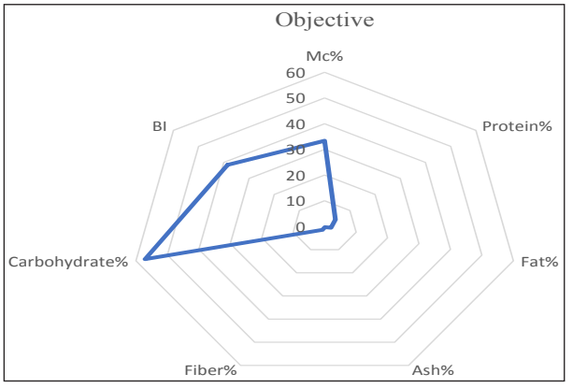
Best Treatment from the concentration and baking temperature of dried cashew apple flour breads

The desirable properties of dried cashew apple flour breads i.e., moisture content, protein content, fat content, ash content, fiber and carbohydrate content, whitening index has been achieved at concentration of flour (C1T2): 95%:05% (refined wheat flour and dried cashew apple flour) and baking temperature at 220° as discussed in table 13.

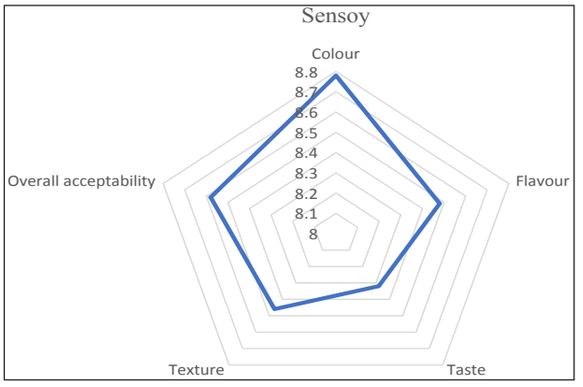
Table 13: Various parameters for the best treatment for dried cashew apple flour muffins Concentration (85%:15%); Baking Temperature (180°C)

Objective Parameters						Sensory Parameters					
MC (%)	**Protein (%)**	**Fat (%)**	**Ash (%)**	**Fiber (%)**	**Carbohydrate (%)**	**WI**	**Colour**	**Flavour**	**Taste**	**Texture**	**OA**
32.391	4.290	2.060	0.290	1.445	59.524	38.47	8.780	8.480	8.320	8.460	8.520

Similarly, the best sensory scores for sensory colour, sensory flavour, sensory taste, sensory texture and sensory overall acceptability have been observed as dried cashew apple flour breads Concentration (95%:05%); Baking Temperature (220°C**)** and at as shown in Fig. 15. Therefore all these proportion at the best treatment are given in Table 13 and Fig. 15 respectively.



(a) Objective Parameters



(b) Subjective Parameters

Fig. 15: (a) Objective and **(b)** Subjective Parameters for Best Treatment. Concentration of flour (C1T2): 95%:05% (refined wheat flour and cashew apple flour) and Baking Temperature at 230°C

CONCLUSION

The best quality of dried cashew apple flour breads, can be produced with incorporation of dried cashew apple flour 5% and refined wheat flour 95% and baking temperature at 230°. With physicochemical properties, Moisture content (db.) 33.391±0.11%, fat content 2.160±0.01%, protein content 4.290±0.09%, ash content 0.290±0.07%, fiber content 1.455±0.07%, carbohydrate 57.100±0.04%, Whitening Index 38.47±0.01 with highest sensory score in all sensory attributes. i.e., colour (8.780), flavour (8.480), Texture (8.460), Taste (8.320), and overall acceptability (8.520).

GENERATIVE AI DECLARATION

The author(s) confirm that there was no use of artificial intelligence (AI)-assisted technology for assisting in the writing or editing of the manuscript, and no images were manipulated using AI. The authors developed and verified all scientific content, data analysis, interpretation of results, and conclusions. The authors take full responsibility for the accuracy, integrity, and originality of the work presented, and no AI tool was listed as an author.

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