International Journal of Research Publication and Reviews, Vol 5, no 12, pp 863-868 December 2024

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Composite Flours in Cake Baking: "A Comprehensive Study of Mineral and Phytochemical Components"

S. Chhotaray[1], C. Devadarshini[2], K. Prathyusha[3]

[1]Research Assistant, [2]Asst. Professor, [3] Asst. Professor
Department of Food &Nutrition, Department of ATS, CCS, Odisha University of Agriculture & Technology, Bhubaneswar- 751003
Email: sumitrachhotaray@gmail.com
DOI : https://doi.org/10.55248/gengpi.5.1224.3421

ABSTRACT

This study was aimed to develop & assess the nutritional quality of different types of cake developed from composite flour made up of soya flour, ragi flour, oats flour and refined wheat flour. Refined wheat flour to composite flour proportion in preparation of cakes were as follows: A_0 (100%:0), A_1(80%:20%) ,A_2 (60%:40%), A_3 (40%:60%) and A_4 (20%:80%). The cakes were studied for their mineral analysis, properties of phyto-chemicals components. The calcium, phosphorus, zinc, iron, and magnesium quantity of cakes (A_0, A_1, A_2, A_3, A_4) developed from composite flour was varied from 64.91mg to 161.5mg%,175.81mg to 274.43mg%, 0.49mg to 2.08mg%,1.90 mg to 4.92mg% and 31.64mg to 76.16mg% respectively. Similarly the total phenol content of developed cakes was also varied from 63.08mgGAE to 81.07 mgGAE/100gm of sample. The phytic acid content of control sample was 16.62mg% whereas 80% substitution of composite flour was found to be 23.28mg% but while estimating oxalate content, it was varied from 1.26mg% to 3.32mg% .The trypsin inhibitor content of control sample to 80% substitute composite flour developed cake was also varied from 0.16TIU/mg to 18.09 TIU/mg. In conclusion, as the composite flour quantity increased the mineral as well as other phytochemical components were also increased but all the estimated results are within safe intake level and also statistically significant to each other. Hence it could make a significant contribution for the consumers as well as bakery industry to develop and create awareness to consume composite flour cake rather normal white flour cake.

Keywords: Phytate, Oxalate, Mineral, Composite flour, Total phenol

1. Introduction:

The increasing global demand for nutritious and functional foods has spurred significant interest in the development of composite flours. Composite flours, which are blends of two or more flours from different sources, have emerged as a promising approach to enhance the nutritional and functional properties of traditional wheat flour-based products. Cakes, a popular bakery item, have traditionally been made from refined wheat flour, which lacks essential nutrients and dietary fiber. The incorporation of composite flours in cake formulations offers a unique opportunity to improve their nutritional quality while maintaining desirable sensory attributes.

The primary motivation behind using composite flours lies in their ability to address nutritional deficiencies and cater to diverse dietary needs. Composite flours often include ingredients such as legumes, tubers, pseudo-cereals, and other nutrient-dense sources. These ingredients not only increase the protein content but also enrich the flour with vitamins, minerals, and bioactive compounds.

Moreover, the use of composite flours aligns with the growing trend of utilizing local crops, which can contribute to food security and sustainability. By diversifying the raw materials used in bakery products, food producers can reduce reliance on wheat, thereby supporting agricultural biodiversity and promoting the utilization of locally available resources.

Several studies have demonstrated the potential benefits of composite flours in bakery products. However, the specific impact on the nutritional quality of cakes, particularly in terms of protein content, fiber content, and micronutrient levels, required comprehensive investigation. This study aims to assess the nutritional quality of cakes developed from various composite flours by analyzing its mineral content, phyto-chemicals and other anti-nutritional factors present in. This research paper seeks to provide a detailed understanding of how composite flours can enhance the nutritional value of cakes.

Significance of the Study

The outcomes of this research will provide valuable insights into the formulation of nutritionally enhanced cakes, offering a practical solution to improve dietary quality through everyday foods. Furthermore, the study will highlight the potential of composite flours as versatile ingredients in the bakery industry, encouraging the adoption of more nutritious and sustainable food production practices.

2. Materials and Methods

2.1 Procurement of raw material:

The raw ingredients used for development of composite flour for cakes are white wheat flour, oats flour, Finger millet flour, soya flour, leavening agents, oil, Milk powder, Milk etc. purchased from local market of Bhubaneswar.

2.2. Formulation of Flours for development of Composite flour:

Ingredients	**Quantity (gms)**
Ragi Flour	50
Soya Flour	30
Oat Flour	20
Total	100

2.2 Processing of raw material: Cleaning, grinding, and sieving of dry flours for removing extraneous materials. Dry roasting is required for ragi flour.

2.3. Recipes for preparation of Cakes

Ingredients (gm)	**Control A_0**	**A_1**	**A_2**	**A_3**	**A_4**
RWF	100	80	60	40	20
CF	0	20	40	60	60
Sugar	50	50	50	50	50
Oil (ml)	50	50	50	50	50
Baking Powder	2.5	2.5	2.5	2.5	2.5
Baking Soda	0.5	0.5	0.5	0.5	0.5
Vanilla essence (tsp)	1	1	1	1	1
Milk (ml)	25	25	25	25	25
Milk Powder	15	15	15	15	15

RWF: Refined wheat flour, CF: Composite Flour

2.4 Mineral Analysis of formulated cakes:

The mineral composition of (calcium, iron, sodium, potassium, zinc, phosphorus and magnesium) different formulated cakes were estimated from the digested samples by using Perkin Elmer AvioTM 200 dual view instrument equipped with Syngistix software. Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES) method was used to measure the elemental concentrations of the products. The digestion process of samples was completed by using di-acid mixture (HNO_3&$HClO_4$).

2.5. Determination of phytochemical components of formulated cakes:

The phytate content of formulated cakes were estimated by using the method outlined by Lucas,(1965) with little modification. In a 250 mL conical flask 2gm of flour was taken. The samples were immersed in a conical flask for 3 hours using 100 mL of 2% Concentration HCl. Then it was filtered by using double-layer filter paper. A 250 mL beaker was filled with 50 mL of each filtrate sample, and 107 mL of distilled water was used to impart the right amount of acidity. Each sample solution was added with 10 mL of 0.3% ammonium thiocyanate solution as an indicator then titrated with a standard iron chloride solution containing 0.00195 g iron/mL.A brownish-yellow coloration identifies the end point which exists for 5 min.

% Phytic acid = T X0.00195 X 1.19 x100 W/2

One gram each of food sample was taken in two separate beakers. In one beaker sample was stirred with 20ml of 0.1M HCL to find out total oxalate and in another beaker, sample was stirred with 20ml of distilled water to extract soluble oxalate. Then both the beaker was marked and sample was digested at boiling point in water bath at 100^0C for 30minutes followed by cooling. Digested sample was filtrated using Whatmann's No 1 filter paper. Then it was cooled. Calcium chloride of 0.5ml was poured to the filter paper to precipitate out Calcium oxalate, after the filtration separate out the precipitate solution and centrifuged at 3500rpm for 15minutes and discarded the supernatant. Washed the calcium oxalate precipitate with 2ml of 0.35ml ammonium hydroxide and then dissolved in 0.5mlof sulphuric acid. For titration dissolved solution was titrated with 0.1M of potassium permanganate. At 60^0C the dissolved solution was titrated till faint pink colour continued till 15 seconds. The Stochiometric formula is used to compute the oxalate content. The soluble oxalate was subtracted from total oxalate to get insoluble oxalate. Both soluble and insoluble oxalates were expressed in dry matter basis.

To determine trypsin inhibitor content of formulated cakes, first sample digestion was completed by taking 0.5gm of cake sample in a cold mortar and pestle containing 25ml water. Then it was kept in refrigerator with occasionally shaking. The sample was centrifuged for 20min.at 4-6^0C.1ml of the supernatant was diluted to 10ml with distilled water.Trypsin inhibitor source dilutions were made so that 0.5mL produced 50% inhibition after that, two different test tubes were taken one as control and other as endogenous. Up to 1ml of extracts were taken in test tubes. The endogenous test tube was filled with buffer up to 2ml mark and the test set's volume was set to 1ml. The test set and standard set was filled with 1ml of trypsin solution. Then all the tubes were incubated at 370C in a water bath. After some time 2.5ml of substrate (1mg BAPNA)was added to each tube. The procedure was continued for 10 to 60 minutes at 370C. By adding0.5mL of 30% glacial acetic acid to the tubes the process was stopped. Then the absorbance was measured at 410nm in spectrophotometer. The Lowry et al technique was used to find out the protein content of the sample.

Total phenol content of formulated cake sample was determined by FC reagent method .The sample was extracted by adding 60ml of solvent (35.35:30: Methanol: Acetone: Water) into 5gm of sample. The resulting mixture was homogenised for 10min. and then for 10min.again centrifuged at 2500rpm.The solvent was removed and 6ml of solvent added for re-extraction. The extract was kept for further estimation. 0.1ml of extract was added with 0.5ml Folin–Ciocalteu reagent& 10 ml of Sodium carbonate solution (75gm/lt.).The final extract was made 25ml with distilled water. After 1hr. of rest the absorbance was measured in spectrophotometer at 750nm against blank. The results were expressed as mg GAE per 100gm of sample (Blanch *et al*.2021).

2.7. Statistical analysis

The mean and standard error of means of the triplicate analyses were calculated. The analysis of variance (ANOVA) was performed to determine significant differences between the means.

3. RESULTS A ND D ISCUSSION

3.1 Mineral composition of Formulated Cakes

Table-1

Mineral content of Composite flour cakes mg/100g on dry matter basis

Types of cakes	**Calcium (mg%)**	**Phosphorus (mg%)**	**Zinc (mg%)**	**Iron (mg%)**	**Magnesium (mg%)**
A_0 (Control)	64.91^e±0.0.47	175.81^e±0.62	0.49^e±0.03	1.90^e±0.30	31.64^e±0.31
A_1	106.58^d±1.16	201.20^d±0.09	0.99^d±0.01	2.86^d±0.41	42.82^d±0.40
A_2	129.25^c±0.03	230.31^c±0.39	1.35^c±0.03	3.26^c±0.53	54.07^c ±0.03
A_3	145.57^b±2.48	251.87^b±0.16	1.77^b±0.09	3.85^b±0.51	68.22^b ±0.56
A_4	161.50^a±1.58	274.43^a±0.30	2.08^a±0.03	4.92^a±0.19	76.16^a ±0.61
CD	4.51	5.09	0.15	0.39	1.9

The calcium content of different formulated composite flour-based cakes has varied from 64.91 to 161.50mg/100gm. Formulated cake A_4 has maximum calcium content followed by A_3, A_2, A_1, & A_0.

The Phosphorus content in formulated cakes were 175.81mg in control group whereas 201.20mg in 20%, 230.31 in 40%, 251.87% in 60% and 274.43% in 80% substitution of composite flour.

The zinc content was varying from 0.49 to 2.08mg/100gm of developed product. Formulated cake A_4 contains maximum zinc followed by A_3, A_2, A_1, & A_0. The formulated cakes were significantly different to each other. The lowest content of zinc was observed in controlled cake A_0. Similarly, the iron content was also maximum in A_4 (4.92mg) followed by A_3 (1.77mg), A_2 (1.35mg), A_1 (0.99mg) & A_0 with 0.49mg per 100gm of composite flour formulated cakes.

The findings of Kaur, H. (2019) on the mineral content of bread were validated with the present study as the lower value of minerals for control sample than the experimental bread sample. The findings of Kaur in respect to the calcium, phosphorus, magnesium, and zinc content in the control bread were 41.68 mg, 173.73 mg, 43.15 mg, and 8.20 mg per 100 g, respectively where as the experimental sample showed varying values with calcium ranged from 65.75 mg to 90.91 mg per 100 g., 179.85 – 233.57mg for phosporus,46.31 – 70.59mg for magnesium & 2.71-3.8mg for zinc found in 100gm of bread developed from varieties of germinated soyabean varieties. Similarly the observation given by Pandit, M., (2019) on mineral contents of composite flour cake S_3 was significantly higher than control sample. The calcium, iron phosphorus & zinc content of control and experimental sample S_3 was 45.45% to 98.11%, 6.26% to 7.73%, 300.87% to 535.96% & 2.77% to 3.23mg respectively. Rana (2015) reported that incorporation of bael powder up to 20 percent significantly increased calcium, iron, zinc and phosphorus content of experimental composite flour based cakes with that of control cake. Calcium content 62.57mg to 108.67mg, zinc content 0.54mg to 1.11mg &phosphorus content 101.83mg to 132.73mg found in control and experimental cake sample respectively. The findings of the present study are also correlate with the above research findings. The increase in micronutrients might be due to the addition of ragi flour up to fifty percent with refined wheat flour

3.2 | Phytochemical components of Formulated Cakes

The phytic acid content of the developed product is increased from control to experimental cakes but there are significant differences seen among the control &experimental cakes. The phytic acid content is maximum among A_4 (23.28%) and minimum in A_0 as 16.62%.

The oxalate content is observed to be increased from control to experimental cakes as the concentration of composite flour quantity increased. In cakes, the trypsin inhibitor is observed to be significantly higher in A_4 (18.09TIU/mg) than that of control A_0 (0.16 TIU/mg).All the developed cakes are significantly different from each other ($p \leq 0.05$).

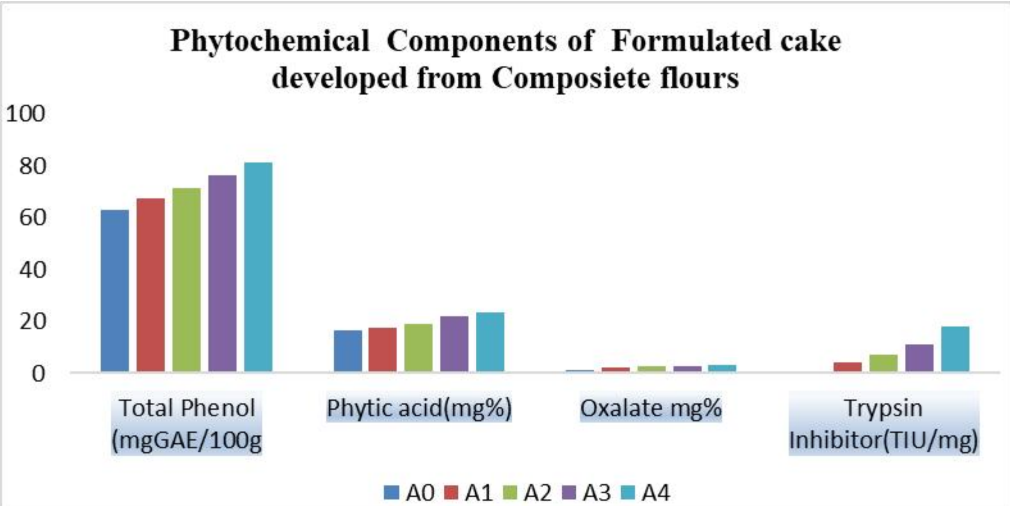

Fig.1

The above table depicted that, the formulated cake A_4 supplemented with 80% composite flour and 20% refined wheat flour was found to be more in total phenol content i.e., 81.07 mg GAE /100g of product followed by A_3 (76.13), A_2(71.38), A_1 (67.16) &least quantity of phenol present in the cake developed from only refined wheat flour, A_0(63.08) mg GAE/100gm of product. Olatunde,*et al.*, (2019) reported on Phytate and Trypsin Inhibitor content of the cakes produced from the blends of pigeon pea, sweet potato & wheat flour. The Phytate content of the control to experimental samples was varying from 1.83-1.48mg & Trypsin Inhibitor content 14.11-47.65 mg/100gm of cakes. But according to the study of Pandit, M., (2019) , the phytate content of experimental cake (70% wheat +15% soya + 10.5% oats +4.5% pumpkin leaf powder) was found to be non-significantly higher than control cake. The total phenol content, oxalate & trypsin inhibitor content of experimental cake were significantly higher than that of the control cake. Kaur (2018) also reported that the phytate content of the experimental pie sample was higher than the control pie

Table-2: Phytochemical Components of Composite flour cakes

Types of Phytochemical components	A_0	A_1	A_2	A_3	A_4	CD	F-Value
Total Phenol (mgGAE/100g)	$63.08^{e}\pm0.04$	$67.16^{d}\pm0.03$	$71.38^{c}\pm0.32$	$76.13^{b}\pm0.01$	$81.07^{a}\pm0.07$	0.46	S
Phytic acid (mg%)	$16.62^{c}\pm0.74$	$17.43^{c}\pm0.46$	$19.17^{b}\pm0.30$	$21.87^{ab}\pm0.34$	$23.28^{a}\pm0.56$	1.6	S

Oxalate mg%	$1.26^{e}\pm0.02$	$2.00^{d}\pm0.04$	$2.68^{c}\pm0.04$	$2.91^{b}\pm0.01$	$3.32^{a}\pm0.06$	0.12	S
Trypsin Inhibitor (TIU/mg)	$0.16^{e}\pm0.00$	$4.13^{d}\pm0.03$	$7.02^{c}\pm0.01$	$11.28^{b}\pm0.13$	$18.09^{a}\pm0.04$	0.2	S

sample. The present study is supported to the phytochemical components of composite flour based bakery products developed by other research findings.

4. CONCLUSION

Bakery sector is one of the main sectors in India's food processing industry. Indian bakery industry has market value of USD 7.22 billion in 2018. India is one of the most interesting regions for the bakery industry since it is the world's third-largest manufacturer of biscuits, after United States and China. Composite flour was initially developed to meet the global wheat crisis and the rising cost of wheat, but due to increase in population, changing lifestyle gradually improves its application in production of functional foods. So, that it will reduce the nutritional deficit among the consumers and enhances better health. The iron, calcium, phosphorus, zinc & magnesium content were significantly ($p\leq0.01$) higher in experimental cake than the control cake. In cake, as the percentage of composite flour increased, all the mineral quantities were also increased. The anti-nutritional components like phytic acid, oxalate & trypsin inhibitor content were significantly higher in experimental samples of cake than control samples. Similarly total phenolic contents of experimental cakes were also significantly higher as compared to control cake. Though the anti nutritional components are gradually increased with increase in concentration of composite flours, still there are decreased from raw flour to final product and it is within permissible range of consumption. The analysis of anti nutritional factors revealed manageable levels, suggesting that the composite flours used do not pose significant health risks and can be considered safe for consumption. Additionally, the total phenol content in the cakes indicates a promising presence of antioxidants, which may contribute to the health benefits associated with composite flour-based products. Overall, the findings highlight the nutritional advantages of using composite flours in cake formulations, offering a viable option for improving dietary mineral intake and providing beneficial bioactive compounds. Further research could explore the optimization of these formulations to maximize health benefits while maintaining desirable sensory properties.

CONFLICT OF INTEREST:

The authors have declared no conflict of interests

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