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Chemical, nutritional, antioxidant and sensory properties of biscuits made from wheat, white bean and carrot composite flour

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Abstract

The present study was carried out to produce biscuits from wheat flour enriched with white bean and carrot composite flour and wheat germ oil and evaluates the quality characteristics of produced biscuits .Wheat flour was replaced in biscuits treatments with white bean and carrot composite flour at rates of 5, 10, 15 and 20%, respectively, also, 2% of the butter used in the manufacture of biscuits was replaced with wheat germ oil in biscuits made from white bean and carrot composite flour. The results showed that biscuits produced from 20% white bean and carrot composite flour had the highest values in protein, ash, and fibre contents compared with control (100% wheat flour) biscuits. Partial replacement of wheat flour with white bean and carrot flour also increased the content of all mineral elements, total phenolic content and radical scavenging activity in fortified biscuits compared with control sample in parallel with increasing the level of substitution. The white bean and carrot composite flour biscuits were more acceptable than those made from wheat flour only (control). The sensory evaluation results showed that white bean and carrot composite flour at 20% replacement is the most acceptable ones in biscuits treatments

Keywords: Phenolic, chemical, biscuits, kidney bean.

1. Introduction

A biscuit is a healthful food that is created from unappealing dough and heated in an oven to make it edible (Ezegbe et al, 2023). Cereal-only biscuits have a very poor quality of protein and other macronutrients, but they are abundant in carbs and have a relatively high glycemic index. This can put a person at risk for diabetes, obesity, and biliary tract cancer (Mudau et al, 2020: Ezegbe et al, 2023).

The fundamental components of biscuit formulation are eggs, sugar, fat, and wheat flour (Akoja& Coker, 2019). Nevertheless, based on the intended or desired sensory and nutritional properties of the finished food, milk, honey, and spices can be added. Biscuits often have a high fat and sugar content and a low moisture content (Ayo et al, 2018). In emerging nations, cereal food products such as biscuits have gained popularity, particularly among children (Ayo et al, 2018). More than half of the calories consumed worldwide come from wheat flour (Triticum aestivum L.), which is a key component in baked goods like biscuits (Masood et al, 2020). Minerals, protein (8–16%), fat (1-3%), and fibre (12–15%) are among the many nutrients found in the complete grain (Senyaetal, 2021). According to Abi Peluola-Adeyemi et al. (2021), the cereal is unusually high in cysteine and methionine but low in lysine and threonine. Legumes, such as cowpea, African yam bean, bambara nut, velvet bean, and soybean, are known to considerably increase a person's intake of protein, minerals, and B-complex vitamins in impoverished nations (Adeyanju et al, 2021). Therefore, adding inexpensive staples from various legumes, cereals, roots, and tubers to wheat flour will help to improve the nutritional quality of wheat products (Urigacha, 2020).

Blending different mixtures of non-wheat flours derived from cereal grains, pulses, tubers, and roots with wheat flour creates composite flours (Hyelsinta &Maijalo, 2016). The concept of utilizing composite flour is not new to the baking industry; in fact, it has been the subject of multiple researches. However, there is a dearth of information regarding biscuits made from mixes of non-wheat and wheat raw materials. Food scientists are always arguing that more flours derived from these by-products should be used instead of conventional wheat flour to reduce waste, improve the nutritional composition of biscuits, and lower the cost of producing biscuits because of the benefits obtained from composite flours, such as enhanced protein and fibre content (Ogo et al, 2021). Based on the aforementioned benefits of composite flours, biscuits have been widely produced over the years by combining wheat with a variety of non-wheat raw materials, such as defatted groundnut (Dauda et al, 2018), chickpea (Lu et al, 2022), and soybean (de Oliveira Silva et al, 2018) and common bean with fluted pumpkin.

Legumes are crucial sources of protein in Egyptian diets and are widely consumed worldwide as they help many low-income

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groups' nutritional status (Akseer et al., 2017; Ahmed et al., 2020). The kidney bean (Phaseolus vulgaris L.) is regarded as a highly nutritious food due to its high protein, crude fibre, carbohydrate, folic acid, vitamin, and mineral content, which includes iron, potassium, phosphorus, and manganese. However, because they obstruct the biological absorption of the nutrients in the legumes, anti-nutritional factors degrade the quality of kidney beans (Kamboj and Nanda, 2018).Members of the Leguminosae bean family include white kidney beans. White beans are a vegetarian substitute for meat since they have about 18 g of protein per 100 g (Maphosa and Jideani, 2017). In addition to being beneficial to the body's cells, red kidney is also a good source of soluble and insoluble fibres, minerals, and vitamins (Ikram et al., 2021; Mullins and Arjmandi, 2021). Furthermore, beans are abundant in phytochemical substances, such as phytosterols, oligosaccharides, and phenolic compounds (Granito et al., 2008). Numerous physiological and health benefits, such as the prevention of cancer, diabetes mellitus, obesity, and cardiovascular disease, have been linked to these phytochemicals (Messina, 2014: Hall et al, 2017). But in addition to these phytochemicals, beans also include antinutrients that hinder the digestion and absorption of nutrients, such as lectins, enzyme inhibitors, phytic acids, and phytates (Farinde et al., 2018).Carrots have a very diverse range of colours. This root vegetable's primary colours include white, yellow, orange, red, and purple. Studies carried out by Xu et al. (2014) revealed that the purple carrot cultivar has a greater anthocyanin concentration. Orange carrot taproots have been found to have a small number of known anthocyanins, while yellow carrot taproots have not been shown to contain any anthocyanins (Xu et al., 2014).In the food sector, carrots are frequently utilised as ingredients in a variety of goods. Longer shelf lives and the creation of innovative, efficient drying methods were the results of this (Turturică& Bahrim et al., 2021). Carrots can be eaten fresh or dried and powdered. They can also be added to a variety of food products, including cakes, soups, sausages, baby foods, candies, jam, and fruit juices, to boost their colour and nutritional value (Mizgier et al., 2016; Akande et al., 2018; Ergun and Susluoglu, 2018).About 10–15% of the entire wheat germ is made up of wheat germ oil (WGO) (Siraj, 2022). Furthermore, n-3 fatty acids (FA), particularly alpha-linolenic acid (Alessandri et al., 2006), fat-soluble carotenoids (Leenhardt et al., 2008), phytosterols, particularly D5-avenasterol (Siraj, 2022), and phenolic compounds (Meriles et al., 2022) are also present in wheat germ. Additionally, WGO exhibits potent antioxidant and anti-inflammatory properties (Harrabi et al., 2021). In addition, wheat germ and its derivatives are said to postpone ageing, reduce cholesterol absorption, slow platelet aggregation, improve physical stamina, increase fertility, and prevent and treat carcinogenesis (M Radi et al, 2021).

What is new in this work is that there are no studies on the use of a complex minute of white beans and carrots in the manufacture of bakery products, so the aim of this work was to produce biscuits from wheat flour enriched with white beans flour, carrot powder and wheat germ oil and evaluate the nutritional value and quality characteristics of produced biscuits compared to wheat biscuit as a superior quality biscuit consumed by all children.

2. Materials and methods

Wheat flour (WF) (72% extraction rate) was obtained from the North Cairo Flour Mills Company, Egypt, other baking materials such as butter; sugar, milk, baking powder, wheat germ oil ,white bean and carrot were purchased from the local market in Cairo, Egypt. All the raw materials were packaged in a clean low density polyethylene bag for better preservation and taken to the Food Processing Laboratory of Department of Food Science and Technology, for further processing .Chemicals were of analytical reagent grade.

Preparation of white bean flour (WBF)

The seeds of white beans were soaked in water at room temperature (25˚C) for six hours, the seeds were boiled in tap water at (100 °C) for 15 minutes until 50% of the seeds were softened when felt between the fingers at the conclusion of the soaking period after the hulls had been physically removed according to Khattab and Arntfield (2009). To obtain fine flour, cooked samples were milled by laboratory grinders (M/S Sujata: New Delhi India) and sieved through 200 μm after being dried in a drying oven at 45˚C ± 5˚C for 18 hours. Until it was required to make biscuits, the flour was stored in an airtight container.

Preparation of carrot flour (CF)

After sorting, washing, and chopping the carrots (Daucus carota), into 1-centimeter cubes, they were immersed in water at 70°C for five minutes to blanch them. After being dried for 24 hours at 50°C, the carrot cubes were ground into flour by laboratory grinders (M/S Sujata: New Delhi India). The resulting carrot flour was sieved using a mesh size of 0.5 mm.

Experimental design

Wheat and white bean and carrot flours were blended at different ratios to obtain composite flours as indicated in Table A. The 100% wheat flour was used as control. Composite flours were used to produce biscuits which were analyzed for their chemical as well as physical and sensory properties.

Biscuit preparation

Samples of biscuits were made using the AACC (2002) procedure, but with a few recipe adjustments. To make biscuits, the dough was prepared using the creaming method, which involved creaming butter or wheat germ oil and sugar for two (2) minutes on medium speed using a Kenwood mixer. Following the creaming process, ingredients including whole milk, baking powder, and flour (or flour blend) were added and thoroughly combined to make dough (see table A for specifics). To make sure the dough was homogeneous, it was kneaded manually. After the dough was moved to a spotless tray, it was carefully rolled with a roller and cut with a cutter into round forms. The formed dough pieces were put in a pan that had been oiled and baked for 20 minutes at 180°C in an oven (SHEL LAB 1370FX, USA). Before packaging, the baked biscuits were taken out of the oven and allowed to cool for thirty minutes on a cooling rack.

Gross chemical composition of raw materials and biscuits

AOAC. (2005) methods have been used to analyse the following constituents of WF, WBF, CF, and biscuit samples: moisture, protein, fat, crude fibre, and ash . By calculating the total nitrogen content by the conversion factors (WF and biscuits (N) × 6.25), (WG (N) × 5.36), and (SBP (N) × 5.7), the percentage of crude protein has been determined. Three copies of the analysis have been completed. Carbohydrates (%) = 100 - (moisture% + ash% + proteins% + fat% + crude fibre%) was the formula used to compute carbohydrates based on this difference.

Mineral composition of raw materials and biscuits

The dry ashing method was used to determine the macro- and microelements (Jones et al., 1991). According to Cheng and Bray (1951), the versenate (EDTA) technique was used to estimate the amounts of calcium (Ca) and magnesium (Mg). The ascorbic acid method was used to determine phosphorus (P) (Watanabe et al., 1965). The flame photometric approach was used to estimate potassium (K) and sodium (Na) (Toth and Prince, 1949). Using inductively coupled plasma (ICP) emission spectroscopy, the following elements were measured: manganese (Mn), iron (Fe), copper (Cu), zinc (Zn), and nickel (Ni) (Donohue et al, 1992).

Total phenolic content

We used the Folin-Ciocalteu technique (Singleton et al., 1999) to determine the total phenolic contents of WF, WBF, CF, and biscuit samples. 50 µl of distilled water was combined with 50 µl of extracts (1 mg/ml) or a standard gallic acid solution (6.25, 12.5, 25, 50, or 100 µg/ml) in distilled water. As a blank, distilled water was utilised.The mixture in a 96-well plate was supplemented with 50 µl of 1 M sodium carbonate solution and 10% Follin Cicocalteu's phenol reagent. The reactions were kept out of the light and incubated for 60 minutes at room temperature. The absorbance was determined using a Microplate Reader (Biotek, USA) at 750 nm. Total phenolic contents in samples were expressed as mg Gallic Acid Equivalents (GAE) per 100 gram of dry plant material. All samples were analyzed in triplicate.

DPPH assay

The DPPH radical scavenging activity was measured using the technique described by Van Hung & Morita (2008). A spectrophotometer (Thermo Scientific, Wilmington, NC, USA) was used to measure the absorbance of the purple-colored DPPH solution at 517 nm. The following
formula was used to determine the scavenging activity:
Scavenging activity (%) = 1 - (Abs sample - Abs blank)/Abs control × 100.

Storage experiments

Biscuit samples were stored for zero, 30, 60 and 90 days at room temperature. Stored biscuits were examined for acid and peroxide value.

Determination of Acid and Peroxide value

A filter paper was used to weigh precisely 7.6 g of milled biscuits before they were wrapped. After the sample was wrapped, it was placed in a Soxhlet extractor along with a distillation flask filled with petroleum ether (30–65 bristles). For almost four hours, the material was extracted continuously (De Castro & Priego-Capote, 2010). Weighing was used to ascertain the lipid content and evaporation at room temperature was used to eliminate the excess solvent.

Acid value

The acid value was calculated using the procedure described in the AOAC (2005). To sum up, 2.50g of oil was dissolved in 25 ml of a 1:1 v/v petroleum ether:ethanol combination, and the liquid was heated for two minutes on a steam bath. Following the addition of two drops of phenol phthalein indicator, potassium hydroxide (0.1N) was added to the solution until a pink hue was visible. Equation: This was used to compute acid value (AV), which was expressed as (mg KOH/g fat):
$AV = V \times N \times 56.1 / \text{Sample weight (g)}$.
Where: N=Normality of KOH., V=ml. of KOH

Peroxide value

A 30 ml solution of glacial acetic acid: chloroform (3:2v/v) was used to dissolve 5.0g of oil. After adding 0.50 ml of saturated potassium iodide and stirring the mixture occasionally for a minute, 30 ml of distilled water was added. Using 0.001N sodium thiosulphate ($Na2S2O3$) and vigorous shaking, the reaction mixture was titrated gradually until the yellow colour disappeared. After adding 0.50 ml (1%, w/v) of starch indicator, the titration was carried out until the blue colour vanished (AOAC, 2005). and the following formula was used to compute the peroxide value (PV) as meq/kg fat:

$PV = S \times N \times 1000/\text{Sample weight (g)}$
Where: S= ml of Na2S2O3 (blank corrected) N= Normality of Na2S2O3

Sensory evaluation of biscuits

Samples of biscuits were made, and they were kept in polyethylene bags with different combinations of time and temperature at room temperature. A panel of thirty individuals, comprising Ph.D. experts, faculty, and students, assessed Biscuit's sensory qualities. The nine-point hedonic scale, which goes from 1 (dislike extremely) to 9 (like extremely), was used for the evaluation (Inyang et al, 2018). The samples were placed in identical containers and coded with three-digit random numbers. The panellists were given access to a questionnaire for submitting scores and drinkable water for mouthwash in between tastings. Every sample was evaluated based on its look, flavour, crispiness, texture, and general acceptance.

Statistical analysis

The analytical data were analyzed using SPSS 16.0 software. Means and standard deviations were determined using descriptive statistics. Comparisons between samples were determined using analysis of one-way variance (AN OVA) and multiple range tests. Statistical significance was defined at (P≤ 0.05).

3. Results and Discussion

Gross chemical composition of raw materials

The gross chemical composition of WF, WPF and CF is reported in Table (1). The moisture and carbohydrate contents of WF (12.42% and 75.43%) were higher than those of WPF (8.12% and76.62%) and CF (6.80% and 73.11%), respectively. WPF was characterized by its higher protein and content (19.20%), while CF had a higher fiber, fat and ash contents (22.30%, 2.24% and 4.60%) , respectively than WF and WPF .

The findings of WF were in close agreement with previously reported by Mahmoud et al,(2023) , who found that WF contains 12.24% moisture, 9.82% Protein, 1,34% fat,0.39 % ash, 0.31% fiber and75.88% carbohydrate. While, the findings of WPF were in close agreement with previously reported by Mananga et al ,(2022) , who found that WPF contains 8.63-9.55% moisture, 23.27- 25.82% protein, 1.66-3,55% fat, 2.67-3.17 % ash, 6.24- 8.39% fiber and 50.94- 56.14% carbohydrate . Also, the findings of WPF were in close agreement with previously reported by Hwang & Hong, (2010), who found that CF contains 8.70 % moisture, 8.01 % protein, 2.41 % fat, 4.80 % ash, 28.23% fiber and 76.08 % carbohydrate. The results presented in Table (1) showed that the gross chemical composition of WPF and CF contained more nutrients compared to WF. Additionally, the CF is characterized as containing much higher levels of total phenolic (mg GAE/100 g), and antioxidant activity (AO) % than WPF and WF, i.e., 595.70 mg/100 g, and 89.70% for CF compared to 374.60 mg/100 g and 74.20% for WPF and 180.70 mg/100 g and 65.80% for WF, respectively.

The results of CF are in line with those reported by Bochnak &Świeca. (2020), which found that CF contains a high level of TPC and showed higher AO %. Also, the results of WPF are in line with those reported by Sęczyk et al,(2021) who found that WPF contains a high level of TPC and showed higher AO %.While the results of WF are in line with those reported by Memon et al,(2020) who found that WF showed a good level of TPC and AO %.

Table (A): Biscuits samples formula

Ingredients	Treatments				
	C	T1	T2	T3	T4
Wheat flour	100	95.0	90.0	85.0	80.0
White bean and carrot composite flours(3:1)	0.0	5.0	10.0	15.0	20.0
Butter	28.0	26.0	26.0	26.0	26.0
Wheat germ oil	0.0	2.0	2.0	2.0	2.0
Whole milk	32.0	32.0	32.0	32.0	32.0
Sucrose	40.0	40.0	40.0	40.0	40.0
Baking powder	1.11	1.11	1.11	1.11	1.11
Vanilla	1.0	1.0	1.0	1.0	1.0
Salt	0.5	0.5	0.5	0.5	0.5

Table (1): Gross chemical composition of wheat, white bean and carrot flours*

Components	Flour type		
	WF	WBF	CF
Moisture%	12.42±0.55a	8.12±0.72b	6.80±0.68 c
Crude protein%	10.30±0.86b	19.20±0.80a	7.82±0.55 c
Crude lipids%	1.40±0.06 c	2.14±0.04b	2.24±0.02a
Total ash%	0.45±0.05c	2.95±0.12b	4.60±0.94 a
Crude fiber%	0.36±0.03c	4.11±0.94 b	22.30±1.02 a
Carbohydrates%	75.43±2.72 a	67.62 ±3.16 b	73.11±3.04 b
TPC mg/100g	180.70±3.14c	374.60±5.22 b	595.70±3.4a
DPPH %	65.80±4.3c	74.20±3.6b	89.70±2.9a

Note: Data are expressed as mean ± standard deviation (n = 3). Values with different superscript letters within a row are significantly different (p < .05)..

Mineral content of raw materials

The evaluation of the macro- and microelement composition of WF, WPF and CF is displayed in Table (2) as mg/100 g sample. CF was found to be a good source of Ca (1499.89 mg/100 g), P (321.40 mg/100 g), Fe (22.40 mg/100 g) , Zn (3.52 mg/100 g) and Na (580.50 mg/100 g) compared to WPF and WF. WPF had the highest content of K (1490.0 mg/100 g), Mg (195.30 mg/100 g) and Cu (0.72mg/100 g) compared to CF and WF. The obtained result about WF, WPF and CF mineral contents was similar to that obtained by Mahmoud et al,(2023) , Timoracká et al,(2011) and Kamel et al,(2023), respectively . WPF and CF powder can be recommended as sources of essential elements. Hence, the nutritive value and mineral content of both of them can play a considerable role in developing bakery products

Table (2): Mineral content of wheat, white bean and carrot flour*

Components mg/100 gram	Flour type		
	WF	WBF	CF
P	76.60±3.14c	95.60±3.70b	184.50±3.16a
K	170.50±4.33c	1420.0±6.4a	520.80±4.20b
Ca	42.30±2.20c	92.30±3.16b	820.30±6.12a
Na	52.80±3.70b	2.02±0.14c	580.50±3.90a
Cu	0.12±0.02c	0.72±0.18a	0.30±0.04b
Fe	1.08±0.04 c	9.22±1.20b	22.40±1.14a
Zn	0.62±0.09 b	3.02±0.56a	3.52±0.64a
Mg	52.70±2.14 b	195.30±3.40a	2.50±0.14c

Note: Data are expressed as mean ± standard deviation (n = 3). Values with different superscript letters within a row are significantly different (p < .05)..

Gross chemical composition of biscuits produced from flour blends

In comparison to the control biscuits, Table (3) displayed the gross chemical composition of biscuit samples supplemented with varying amounts of white bean and carrot composite flour. It was discovered that the biscuit samples' moisture contents varied from a low of 5.42% in the 20% with bean and carrot composite flour biscuits to a maximum of 6.46 % in the control sample. The range of 8.57% to 9.71 % was discovered for the protein content. Biscuits ranged in ash percentage from 1.72% to 2.42%. However, there was no change in the amount of fat found in the biscuit samples. As the percentage of bean and carrot composite flour was substituted, the fibre content of the biscuits grew gradually in all samples. This observation may be connected to the high fibre content of the raw materials employed in the combinations at first. All samples showed a decrease in the amount of carbohydrates when the fraction of bean and carrot composite flour substituted was increased.

The 20% white bean and carrot composite flour biscuits had higher protein, fat, ash, and fibre contents than the control biscuits. Furthermore, when compared to control biscuits, all of the biscuits developed for this study may be classified as bakery goods with significant fibre content. These results are consistent with those of Sparvoli et al. (2016), who found that adding bean flour to biscuits enhanced their protein, fat, ash, and fibre content considerably ($P < 0.05$). Similar trends were previously seen by Xhabiri et al. (2023), who reported that the protein, fat, ash, and fibre content of biscuits were dramatically boosted by the inclusion of local bean flour. Also, Guyih et al. (2020) showed that addition of almond seed and carrot flour blends increased the amount of protein, fat, ash and fiber content with increasing almond seed and carrot flour blends levels in biscuits. Gawai et al, (2023) showed that addition of pineapple and carrot pomace powder blends increased the amount of protein, ash and fiber content with increasing pineapple and carrot pomace powder blends levels in biscuits.

Minerals content of biscuits

The copper content of the biscuits increased dramatically with substitution, as shown in Table 4, and varied from 0.06 mg/100 g for the control to 0.41 mg/100 g for 20% white bean and carrot composite flour biscuits. Numerous enzymes and chemical processes involve copper in their operation. It is crucial for the myocardium's (the heart muscle's) correct operation and is involved in the oxidation of glucose. By influencing mood, sleep, memory, and attention, copper affects the quality of cartilage, the mineralization of bones, and the modulation of neurotransmitters. Additionally, iron metabolism and the immune system are also impacted by copper (Davis, 1987). With an intake of 0.41 mg/100 g, white bean and carrot composite flour biscuits would be a decent source of copper.

With substitution, the iron content of biscuits dramatically rises ($P \leq 0{:}05$). 20% white bean and carrot composite flour biscuits have the highest score (0.97 mg/100 g), while the control biscuits have the lowest level (0.35 mg/100 g). Red blood cell production is also aided by iron. Additionally, it facilitates electron transfer processes, fixes nitrogen for the formation of deoxyribonucleic acid, and transports oxygen (Brissot et al., 2018).

The Zinc concentration likewise rises dramatically ($P \leq 0{:}05$). A 20% white bean and carrot composite flour biscuit has the highest score (0.65 mg/100 g), while cake the control has the lowest level (0.31 mg/100 g). Zinc contributes to the catalytic and metabolic functions of almost 300 enzymes by forming their active sites. Additionally, it helps with the secretion of digestive enzymes and the storage and release of insulin (Chasapis et al., 2020). A 20% white bean and carrot composite flour biscuit contains the most zinc of the three biscuit.

The calcium content of the biscuit was considerably increased (P ≤ 0:05), ranging from 33.60 mg/100 g for control to 126.84 mg/100 g for a 20% white bean and carrot composite flour biscuit. Both the transmission of nerve impulses and the process of muscle contraction both involve calcium. It contributes to the process of blood coagulation as well as the metabolism of several hormones. In the growth stage, a calcium deficit causes rickets, and in adults, it causes osteomalacia(Cianferotti, 2022). The biscuit made from WF, white bean and carrot composite flour mixture would be helpful for boosting bone density and lowering calcium deficiency.

The amount of magnesium in the biscuit similarly rose considerably with substitution (P ≤ 0:05), and varied from 6.90 mg/100 g for the control to 16.65 mg/100 g for 20% white bean and carrot composite flour biscuits .Magnesium is essential for the body's metabolic processes, including those that preserve muscle, enhance neuronal function, keep the heart rate constant, and control blood sugar (Dent & Selvaratnam, 2022). The most advantageous 20% white bean and carrot composite flour biscuits would then be in terms of magnesium intake.

The potassium content in the biscuits also increased significantly (P ≤ 0:05), going from 125.85 mg/100 g for the control to 219.54 mg/100 g for c20% white bean and carrot composite flour biscuits. Along with substitution comes an increase in potassium concentration. This increase is actually the result of the inclusion of white bean and carrot composite flour in the formulation. Potassium is crucial for lowering blood pressure. Consequently, potassium-rich 20% white bean and carrot composite flour biscuits are advised for hypertension patients.

The sodium content in the biscuits significantly increased with substitution (P ≤ 0:05) and ranged from 46.28 mg for the control to 145.01 mg/100 g for 20% white bean and carrot composite flour biscuits.

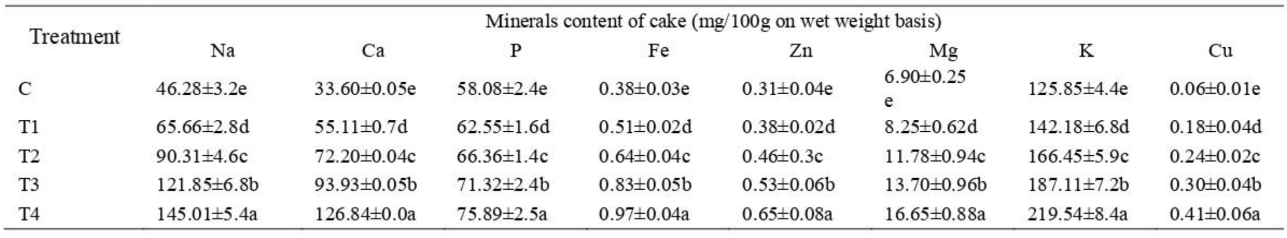
The results of this study are comparable to those found by Inyang et al, (2018) who found that substitution of wheat flour with 25% kidney bean flour increased all minerals content of biscuit .Also, Sule et al, (2019) found that substitution of wheat flour with carrot flour increased Ca, K, Fe and Na contents of biscuit.

Table (3): Chemical composition of biscuits made from wheat, white bean and carrot composite flour

Treatment*	Chemical composition (% on wet weight basis)					
	Moisture	Protein	Ash	Crude fiber	Fat	Total carbs
C	6.46b±0.22a	8.57±0.12e	1.72±0.05e	0.76±0.14e	15.35±0.25a	67.90±0.24a
T1	6.16±0.18 b	8.88±0.16d	1.854±0.07d	1.07±0.12d	15.47±0.20a	67.46 ±0.16b
T2	5.92±0.28c	9.17±0.24c	2.04±0.04c	1.46±0.16c	15.58±0.26a	67.29 ±0.24c
T3	5.66±0.20d	9.42±0.18b	2.25±0.06ab	1.70±0.14b	15.65±0.24a	67.02±0.20d
T4	5.42±0.16e	9.71±0.22a	2.42±0.05a	2.03±0.15a	15.73±0.28a	66.72±0.18e

Note: Data are expressed as mean ± standard deviation (n = 3). Values with different superscript letters within a row are significantly different (p < .05)..
C: biscuits manufacture with wheat flour (72% ext.).
T1: biscuits manufacture with 95 % wheat flour+ 5% white bean and carrot composite flour (3:1).
T2: biscuits manufacture with 90 % wheat flour + 10% white bean and carrot composite flour (3:1)..,
T3: biscuits manufacture with 85 % wheat flour + 15% white bean and carrot composite flour (3:1)..
T4: biscuits manufacture with 80 % wheat flour + 20% white bean and carrot composite flour (3:1).

Table (4): Minerals content of biscuit made from wheat, white bean and carrot composite flour



Treatment	Minerals content of cake (mg/100g on wet weight basis)							
	Na	Ca	P	Fe	Zn	Mg	K	Cu
C	46.28±3.2e	33.60±0.05e	58.08±2.4e	0.38±0.03e	0.31±0.04e	6.90±0.25 e	125.85±4.4e	0.06±0.01e
T1	65.66±2.8d	55.11±0.7d	62.55±1.6d	0.51±0.02d	0.38±0.02d	8.25±0.62d	142.18±6.8d	0.18±0.04d
T2	90.31±4.6c	72.20±0.04c	66.36±1.4c	0.64±0.04c	0.46±0.3c	11.78±0.94c	166.45±5.9c	0.24±0.02c
T3	121.85±6.8b	93.93±0.05b	71.32±2.4b	0.83±0.05b	0.53±0.06b	13.70±0.96b	187.11±7.2b	0.30±0.04b
T4	145.01±5.4a	126.84±0.0a	75.89±2.5a	0.97±0.04a	0.65±0.08a	16.65±0.88a	219.54±8.4a	0.41±0.06a

Data are expressed as mean ± standard deviation (n = 3). Values with different superscript letters within a row are significantly different (p < .05)..
C: biscuits manufacture with wheat flour (72% ext.).
T1: biscuits manufacture with 95 % wheat flour+ 5% white bean and carrot composite flour (3:1).
T2: biscuits manufacture with 90 % wheat flour + 10% white bean and carrot composite flour (3:1)..,
T3: biscuits manufacture with 85 % wheat flour + 15% white bean and carrot composite flour (3:1)..
T4: biscuits manufacture with 80 % wheat flour + 20% white bean and carrot composite flour (3:1).

Total phenolic and radical scavenging activity of biscuits

Results presented in Table 5 showed that the partial replacement of wheat flour with white bean and carrot composite flour increased total phenolic content and radical scavenging activity of biscuits samples compared with control biscuits sample in parallel with increasing the level of substitution. Biscuit treatments containing 20% white bean and carrot composite flour had the highest total phenolic content and radical scavenging activity , while control sample had the lowest total phenolic content and radical scavenging activity, this may be due to a high phenolic content of carrot (Bochnak &Świeca., 2020) and white bean (Sęczyk et al,2021) . Such data are in line with those obtained by Hussain et al (2022) and Catană et al (2022) , who found that addition of carrot powder to biscuit increased the phenolic content and radical scavenging activity of product .Also, Chakraborty & Chakraborty , (2023) found that addition of white bean powder to biscuit increased the phenolic content and radical scavenging activity of product. Also, adding wheat germ oil to treatments in which wheat flour is partially replaced with bean and carrot flour may contribute to increasing the total phenols content and the antioxidant activity of the biscuit treatments as a result of the good content of wheat germ oil of phenolic substances (Zou et al, 2018).

Table (5): Total phenolic content and radical scavenging activity of biscuit made from wheat, white bean and carrot composite flour

Treatment*	Total phenolic content(mg/100g)	Radical scavenging activity (%)
C	66.20±7.4e	30.50±2.8e
T1	94.70±5. 6d	35.30±3.2d
T2	130.50±6.2c	39.80±5. 4bc
T3	170.90±4.5b	45.60±4.9b
T4	210.30±5.8a	52.5±4.8a

Data are expressed as mean ± standard deviation (n = 3). Values with different superscript letters within a row are significantly different (p < .05)..

C: biscuits manufacture with wheat flour (72% ext.).

T1: biscuits manufacture with 95 % wheat flour+ 5% white bean and carrot composite flour (3:1).

T2: biscuits manufacture with 90 % wheat flour + 10% white bean and carrot composite flour (3:1)..,

T3: biscuits manufacture with 85 % wheat flour + 15% white bean and carrot composite flour (3:1)..

T4: biscuits manufacture with 80 % wheat flour + 20% white bean and carrot composite flour (3:1).

Sensory evaluation of biscuits

In order to determine if a food product will be accepted or not, sensory analysis of any food item is a crucial step in the creation process. Table 6 displays the mean ratings of the sensory qualities of the biscuits created in the current investigation. The outcome demonstrated that the panellists' average ratings for each sample's look, flavour, texture, crispiness, and general acceptability differed. Taste and appearance are significant sensory factors that influence whether or not customers will find any food product acceptable. The appearance mean score values were considerably higher ($p<0.05$) than the mean score values for the white bean and carrot composite flour samples, ranging from 6.68 (T4) to 7.22 (C). The taste category's typical score values varied from 6.54 (C) to 7.12 (T4).The samples of white bean and carrot composite flour had taste scores that were noticeably higher than the control samples' mean scores. The biscuits received scores ranging from 6.48 (C) to 7.04 (T4) for texture and 5.90 (C) to 7.20 (T4) for crispiness. Sample T4's texture was the most favoured since its mean score value (7.20) was considerably greater than that of the other samples. Among the white bean and carrot composite flour samples, the control sample (C) received the lowest mean score (5.90) for crispiness, and the value was considerably ($p<0.05$) lower. The overall acceptability mean score values varied from 7.44 (T4) to 7.00 (C). The fact that biscuits with scores higher than 5 (neither like nor dislike) suggests that all of the formulations were deemed satisfactory. In terms of overall acceptability, sample C, scoring 7.00, was the least liked sample, while sample T4, with the highest score of 7.44, was the most preferred sample.

For the composite flour biscuits made with white beans and carrots, there was a progressive decline in appearance qualities. This resulted from the carrot's deeper hue. This can be explained by the fact that the panellists were able to visually discriminate between the samples solely on the basis of colour and the level of surface imperfections that were visible. Table (2) indicates that the amount of moisture in the biscuit samples gradually decreased, which resulted in a decline in the biscuit's surface appearance value and a deeper colour after baking. This could be the source of the appearance values dropping. Appearance, moisture content, and total carbs are positively correlated. On the other hand, ash, fat, and crude fibre have a negative correlation with appearance (Man et al., 2021). When evaluating how well-received a product is by consumers, texture is crucial. Most of the time,a consumer's taste for a product is largely unconscious and is influenced by its texture. Mouth behaviour, or the intricate changes in texture that occur during eating, might affect whether a product is accepted or rejected (Gyura et al, 2005). Additionally, according to Man et al. (2021), there is a positive correlation between the biscuit's taste and aroma and its protein, ash, fat, and crude fibre content, and a negative correlation between it and moisture and total carbohydrates. These results agree with Inyang et al. (2018), who found that the partial replacement of wheat flour with kidney bean flours improved the sensory score of biscuit. Also, adding wheat germ oil to treatments in which wheat flour is partially replaced with bean and carrot flour may contribute to increasing the sensory judgment rates of biscuit treatments as a result of the good taste of wheat germ oil.

Table (6): Average sensory score of different parameters in control and treated biscuit samples (9-point hedonic scale)

Treatment*	Sensory parameters				
	Appearance	Taste	Texture	Crispiness	Overall acceptability
C	7.22±0.06a	6.54±0.05e	6.48±0.11e	5.9±0.10e	7.00±0.08e
T1	7.04±0.08b	6.62±0.03d	6.60±0.09d	6.18±0.14d	7.14±0.06d
T2	6.95±0.11c	6.77±0.06c	6.74±0.07c	6.50±0.18c	7.22±0.11c
T3	6.82±0.09d	6.92±0.04b	6.85±0.12a	6.94±0.11b	7.35±0.09b
T4	6.68±0.07e	7.12±0.03a	7.04±0.06a	7.20±0.09a	7.44±0.07a

Data are expressed as mean ± standard deviation (n = 3). Values with different superscript letters within a row are significantly different ($p < .05$)..

C: biscuits manufacture with wheat flour (72% ext.).
T1: biscuits manufacture with 95 % wheat flour+ 5% white bean and carrot composite flour (3:1).
T2: biscuits manufacture with 90 % wheat flour + 10% white bean and carrot composite flour (3:1)..,
T3: biscuits manufacture with 85 % wheat flour + 15% white bean and carrot composite flour (3:1)..
T4: biscuits manufacture with 80 % wheat flour + 20% white bean and carrot composite flour (3:1).

Peroxide value (PV) and acid value (AV) of fat extracted from biscuit samples

Throughout the course of the biscuits' three-month storage duration at room temperature, the peroxide value (PV) and acid value (AV) of the white bean and carrot composite flour were monitored, with the outcomes shown in Table 7. Table 7 showed that PV and AV rose steadily in all samples until the conclusion of the storage period. The PV of the lipids recovered from the control sample at zero time (after baking) was 0.25 meq/kg fat, which was similar to the other biscuit samples' PV, which varied from 0.24 to 0.25 meq/kg fat.

Table (7): Peroxide value (PV) and acid value (AV) of biscuits fat at different storage periods

Treatment*	Parameters							
	AV (mg KOH/g fat)				PV (meq/kg fat)			
	Zero time	30 days	60 days	90 days	Zero time	30 days	60 days	90 days
C	0.22±0.02a	0.40±0.03a	0.58±0.04a	0.65±0.04a	0.25±0.02a	2.74±0.02a	4.55±0.02a	5.70±0.02a
T1	0.21±0.01a	0.36±0.02b	0.53±0.03b	0.61±0.04b	0.24±0.02a	2.60±0.02b	4.10±0.02b	5.20±0.02b
T2	0.22±0.01a	0.33±0.02c	0.49±0.04c	0.57±0.03c	0.25±0.02a	2.54±0.02c	3.60±0.02c	4.40±0.02c
T3	0.22±0.02a	0.28±0.03d	0.45±0.03d	0.52±0.05d	0.24±0.02a	2.02±0.02d	3.05±0.02d	3.90±0.02d
T4	0.21±0.01a	0.24±0.03e	0.40±0.04e	0.47±0.04e	0.25±0.02a	1.60±0.02e	2.70±0.02e	3.30±0.02e

Mean Data are expressed as mean ± standard deviation (n = 3). Values with different superscript letters within a row are significantly different ($p < .05$)..

C: biscuits manufacture with wheat flour (72% ext.).
T1: biscuits manufacture with 95 % wheat flour+ 5% white bean and carrot composite flour (3:1).
T2: biscuits manufacture with 90 % wheat flour + 10% white bean and carrot composite flour (3:1)..,
T3: biscuits manufacture with 85 % wheat flour + 15% white bean and carrot composite flour (3:1)..
T4: biscuits manufacture with 80 % wheat flour + 20% white bean and carrot composite flour (3:1).

All of the biscuit samples showed an increase in PV; however, after 90 days, the control biscuits had the highest value (5.70 meq/kg fat), whereas the other biscuit samples' PVs ranged from 3.30 to 5.20 meq/kg fat.

Because rancidity develops after storage, biscuits—which are the least stable macro components in food—become unpalatable and are rejected by the panellists(Mohamed et al, 2014). According to Jeyasanta et al. (2013), biscuit fat peroxide readings were consistently within the permissible range of 10–20 meq/kg of fat over the course of storage.

All biscuit samples showed an increase in AV value at the same period following storage. The control biscuits had a far larger increase. The average volatile content (AV) of the fat extracted from the control biscuit at zero time was 0.22 mg KOH/g. This value was similar to the other variants, which had AVs ranging from 0.21 to 0.22 mg KOH/g. All of the biscuit samples showed a rise in AV as well; after 90 days, the control biscuits had the highest value (0.65 mg KOH/g fat), while the other biscuit samples' AVs varied from 0.47 to 0.61 mg KOH/g fat. The decrease in PV and acidity of biscuits with white bean and carrot composite flour way be due to a high phenolic content and antioxidant activity of white bean (Sęczyk et al, 2021) and carrot (Bochnak &Świeca, 2020) compared to wheat flour. Also, adding wheat germ oil to treatments in which wheat flour is partially replaced with bean and carrot flour may contribute to reducing the values of peroxide and acid values as a result of the strong antioxidant activity of wheat germ oil (Zou et al, 2018) .

Conclusion

The goal of the current study was to determine the value of enriched biscuits made with white bean and carrot composite flour as a healthy and sensible meal additive. As a result, white bean and carrot composite flour are full of numerous essential elements. It can be utilised in the formulation of biscuits, a popular bakery item all over the world. The finest addition might be to replace the wheat flour with 20% white bean and carrot composite flour. On the other hand, because all of the sensory quality aspects of the biscuits were higher compared to control, replacing the wheat flour with 20% white bean and carrot composite flour might be regarded as the best addition. Different white bean and carrot composite flour mixtures could be used to make biscuits, especially when the sweet potato content is 20% .

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