Preparation and Evaluation of Wheat- Baobab Composite Flour and its Uses for Producing Biscuits and Crackers

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ABSTRACT

This study aimed to partially replace wheat flour (WF) with baobab flour (BF) to formulate composite flour (WBF). The replacement ratios were 5%, 10% and 20%. for biscuits and crackers manufacturing. Proximate analysis results showed significant ($P\leq0.05$) increase in ash from 0.94 to1.41%, fiber 0. 19 to 0. 96 %, and nitrogen free extract 81.76 to 81.89, while moisture decreased from 14.01 to 13.32% protein 14.49 to 14.20 and fat 2.81to 2.48 as the BF substitution level rises. The phytochemical of the blended wheat, increased as the levels of BF increased .The phenolic substances managed between 52.04 to 111.61 mg, and antioxidant activity 52.66 to 77.13 estimated by DPPH method. The composite flour contained considerably higher amounts of the following mineral elements: Ca, K, Mg, Fe, Mn and Zn, as compared to the control (WF). Moreover, WBF exhibited higher amounts of phenylalanine and histidine on contrary to leucine and cysteine as compared to the control (WF). Sensorial evaluation indicated that 5% replacement ratio was the significantly ($P \leq 0.05$) comparable to the control as judged by panelists.

Key words: wheat flour, baobab flour, composite flour, chemical compositions, biscuits, crackers.

INTRODUCTION

The baobab tree (*Adansonia digitata L*) is originally situated in Africa but can still be discovered in large quantities in America, India, Malaysia and other nations. The plant is widely distributed throughout the semi-arid and arid regions of tropical Africa to the south of the Sahara and sub-humid regions as well as in Western Madagascar (Abiona *et al.,* 2015). Baobab is a renowned tree in Sudan. It is a part of the Bombacaceae family and is commonly referred to as *Tabaldi*. It has a distinctive fruit variety with a wooden pericarp enclosing a soft pulp with kidney-shaped seeds (Sidibe & Williams, 2002). In the countryside particularly in Western Sudan, the indigenous population relies on baobab pulp for the cure of certain ailments and it is frequently consumed as a drink.

The fruit pulp of the baobab tree has been found to enhance food items such as grains, energy bars, and other cooked goods because of its exceptional nutritional characteristics (Aluko *et al.,* 2016). Numerous macronutrients and micronutrients are plentifully found in the baobab fruit pulp. For example, the pulp is a bountiful source of dietary fiber, iron, zinc (Muthai *et al*., 2017), vitamin C, magnesium, calcium, and potassium (Stadlmayr *et al*., 2020).The supplementation of baobab in different forms offers an opportunity to address the diverse deficiencies of micronutrients in diets.

The pulp of the baobab fruit is regarded as a nutraceutical due to its inclusion of various bioactive natural components with properties that promote health (Gahane & Kogje, 2013). In 2008, the European Union Commission sanctioned the use of the baobab fruit as an innovative food component (Vassiliou., 2008, Stadlmayr *et al*., 2020). In the Savannah regions of Sub- Saharan Africa, the baobab fruit pulp has been appreciated as a source of food through its incorporation into various traditional delicacies (Buchmann *et al*., 2010).

In Sudan, the use of indigenous fruits is primarily associated with ecological challenges like drought, desertification, scarcity of food and famine, and specifically with the ongoing conflict in Kordufan and Darfur. Baobab fruits and pulp have a significant role in Sudan's culinary traditions and are regularly eaten by the local population, primarily as quick bites without requiring additional preparation, as drinks, or incorporated into porridge (Dirar,1993, Salih & Ali, 2014).

Wheat is a higher quality cereal grain in confectionary sectors than alternative cereals because it includes gliadin and glutenin(Asrani *et al*., 2023). However, wheat is not a tropical crop, and only a handful of African nations possess the necessary climate to facilitate its cultivation. Consequently, substantial amounts of money are expended annually in Africa to import wheat in order to satisfy the growing need for wheat-derived goods (Grote *et al*., 2021). Due to the exorbitant expense of importing it, it is vital to seek alternative sources of raw materials that can substitute for wheat like baobab in order to reduce dependence on wheat imports. Presently, the manufacture of composite flour is an intriguing choice and has been extensively embraced globally for the enhancement of functional foods with the essential nutritional content and promotion of health advantages (Awolu *et al*., 2017)

Many developing nations are also embracing the utilization of blended flours in bakery and confectionery food items to enhance health and economic aspects and to decrease the expenses of importing wheat (Olaoye *et al.*, 2006).This has compelled investigation into partly replacing wheat flour with alternative fruit such as baobab for food manufacturing. (Eke-Ejiofor & Deedam,2015).

The primary flour source for biscuits is wheat (Denis, 2011). Nonetheless, it is well known that wheat flour has a limited nutritional value. In fact, wheat grains have an uneven distribution of a number of bioactive components.The bran, aleurone, and germ contain between 50 and 60 percent of the minerals and vitamins (Chavan *et al*., 1993). As a result, during milling, these ingredients are eliminated entirely or in part, resulting in a lower nutritional quality.Consequently, adding baobab flour to the recipe of snacks may enhance their nutritional value while also contributing to their health-promoting qualities. (Karim *et al.*, 2000).

A cracker is a dry, flat baked food that is usually made of unleavened and unsweetened dough and is typically made with wheat flour. The snack crackers are a type of cracker that are typically baked, salted, flavored, and sprayed with fat after being chemically leavened (Manley, 2000).

The present study aimed to prepare and evaluate composite flour produced from wheat flour and baobab flour. The resultant composite flour was evaluated to make biscuits and crackers.

MATERIALS AND METHODS

Materials

Wheat flour (72%), butter, baking powder, salt and sugar were purchased from market in Alexandria, baobab fruit was procured from a local market in Sudan.

Methods

Technological methods

The baobab fruit pulp flour was produced using a modified version of the methodology of(Diop *et al*., 2005). To prevent shattering the seeds and to improve the separation of fibers from seed and pulp, the baobab fruit pulp (*Andansonia digitata*)

Baobab fruit pods

Baobab fruit pulp

Baobab seeds

Baobab pulp flour

Fig. 1: The different parts of baobab fruit

was softly crushed in a mortar. To produce baobab pulp flour, the pulp was then violently crushed and sieved through a sieve with a 200-mesh opening (Benkidra, 2010).

Preparation of composite flour

A two-element enhanced combination design was employed to produce the mixtures of wheat and baobab flours based on sample proportion, which were outlined as: WFa (100:0) representing 100% wheat flour and 0% baobab pulp flour, WBFb (95:5) representing 95% wheat flour and 5% baobab pulp flour, WBFc (90:10) representing 90% wheat flour and 10% baobab pulp flour and WBFd (80:20) representing 80% wheat flour and 20% baobab pulp flour.

Formulation and Production of Biscuit

This was done using the (method of Miller and Methew.1985) with some modification. Sugar (250g) and butter (250g) were mixed. In another vessel, dry ingredients (500g of flour, 10g baking powder and 2g salt) were sieved and mixed properly. The dry ingredients were then poured into the liquid mixture and kneaded till a homogenous dough was obtained. Then cut with a biscuit mold to desired shapes. They were later baked at a temperature of 200°C for 10 minutes. The biscuits were allowed to cool completely at room temperature after which they were packaged in plastic bags.

Cracker preparation

The formula for making cracker was prepared according to the method described by (Konstantinos *et al*., 2023), with some modification included 500g of flour, 200g of water, 100g of oil, 10g of baking powder, 1g of salt and 2g sugar. All ingredients were then combined to produce a dough. After quick kneading, the dough was allowed to rest for 30 minutes at room temperature. The crackers were baked at 170°C in a baking oven and packed in plastic wraps after cooling in room temperature.

Chemical method

Proximate chemical composition

The proximate chemicalcomposition (moisture, ash, crudefat, crude fiber and crude protein) of the control and flour blend samples were determined using the Association of Official Analytical Chemists techniques (AOAC, 2012). The difference was calculated to determine the total carbohydrates.

Antioxidant activity

The DPPH free radical test was used to determine each substance's percentage of antioxidant activity (AA%) as published by Brand *et al*. (2011) was used to test the DPPH radical scavenging activity. Using a UV-VIS spectrophotometer, the colour changes (from deep violet to light yellow) will be read at 517 nm after 100 minutes of reaction.

Total phenolic content

The Folin Ciocalteu assay was used to estimate the total phenolic content acording to Siddiqui *et al*. (2017).

Minerals determination

Ash was determined by combustion of the sample in a muffle furnace at 550°C for 12h. The mineral constituents (Ca, K, Mg, Feand Zn) were analyzed using theAtomic Absorption Spectrophotometer (SHIMADZU). (AOAC, 2012).

Amino Acid Profile

The amino acid compositionwasevaluated using high-performance liquid chromatography (HPLC). The concentration of each amino acid was determined from the area under the peak (Hofmann *et al*, 2003).

Sensory Evaluation

The biscuit and cracker samples were evaluated for colour, flavour, taste, texture and overall acceptability on a nine-point hedonic scale, where nine represents like extremely (the highest) and one represents dislike extremely (the lowest).The evaluation was done by 20 semi-trained panelists selected from the staff and students of Food Science and Technology Department, Alexandria University, Egypt.

Analysis of Data

Determinations were carried out in triplicates and the errors were reported as standard deviation from the mean. Analysis of variance (ANOVA) was performed and the least significant differences were calculated with the SPSS software for Windows, release 16.00, SPSS Inc., accepted at $P \leq 0.05$ level.

RESULTS AND DISCUSSION

The proximate chemical compositionfor wheat flour and itsmixtureswith baobab flour is shown in

Table (1). The BPF has considerably greater ash and fibre content ($P \leq 0.05$) compared to WF. Moisture, protein, and lipid levels were substantially greater in WFa than BPF. The data indicated that the level of moisture content varied from 13.98% in WFa to 13.32% in WBFd. The moisture content was found to decrease from14.01%to 13.32%by-increasing baobab pulp flour (BPF) level from5% to 20% ($P \leq 0.05$). The decrease in moisture content extends the shelf life of the flour blends Eddy *et al*. (2007).On the other hand, the protein content decreased from 14.49% to 14.20% with the increase of BPF content from 5% to 20%,which means that the protein content of the composite flour was reduced as a result of increasing the replacement of BF in the formulation.This result is in accordance with Barakat (2021).

With the gradual addition of BF, there was a small decrease in the lipid content of the composite flours from 2.81% in WBFb to 2.48% in WBFd. Notwithstanding there was an increase in fiber content from 0.19% in WBFb to 0.96% in WBFd. The rise in fiber concentration may be attributed to the abundant fiber in the baobab flour. Agu *et al*. (2020) have also documented a comparable outcome. Consuming fiber-rich food can potentially prevent constipation, heart disease, and high blood pressure.

Also, the ash content increased from 0.94% in WBFb to 1.41% in WBFd. The results showed that the ash content increased with increasing baobab inclusion. This is in agreement with the findings of Osman, (2004) who reported that baobab is rich in mineral elements content. Ash content is an index of the amount of minerals present in a food sample (Md Noh *et al*., 2020).

The total phenolic content and the antioxidant activity of all formulated flours were measured using DPPH. The results are showin in Table (2). Total phenolic content varied from 43.35 in WFa to111.61 mgGAE/g in WBFd.The significantly ($P \leq 0.05$) highest DPPH radical scavenging activity was observed in WBFd (77.13%), whereas WBFb represented significantly ($P \leq 0.05$) the lowest DPPH scavenging effectiveness (52.66%) and WFa exhibited significantly ($P \leq 0.05$) the lowest value (42.51%). The DPPH scavenging activity was found to increase with the total phenolic content in different products.It was noted that the mix of baobab pulp flour with wheat flour had a significant impact on all the chemical characteristics ($P \leq 0.05$),such a finding is in agreement with-Barakat (2021) who noted an increase in polyphenol concentrations with the inclusion of a greater

Table 2: The total phenolic content and antioxidant activity of wheat flour and the composite flours

Samples	Nutritional Attributes	
	Total phenolic (mg GAE g-1 dw)	Antioxidant activity, DPPH (mg TE g-1 dw)
WFa	43.35c±3.73	42.51d±355
WBFb	52.04bc±3.09	52.66c±1.86
WBFc	67.34b±5.44	66.39±1.48b
WBFd	111.61a±18.55	77.13a±0.66

Values followed by the same letters in the same columns are not significantly different (P≤ 0.05).

WFa: 100% wheat flour: 0% Baobab fruit pulp flour, WBFb: 95% wheat flour: 5% Baobab fruit pulp flour

WBFc: 90% wheat flour: 10% Baobab fruit pulp flour,WBFd: 80% wheat flour: 20% Baobab fruit pulp flour

Table 1:Proximate chemical composition of wheat flour, and its composite flours

Samples	Chemical Composition					
	Moisture (%)	Protein (%)	Fat (%)	Ash (%)	Crude fiber (%)	NFE (%)
BPF	9.03^{d}±0.17	2.33±0.16^{c}	0.95 ± 0.04^{c}	6.81± 1.91^{a}	4.65^{a}±0.09	81.04^{bc} ± 0.25
WFa	13.98^{ab}±0.07	14.52^{a}±0.20	1.45^{b}±0.19	0.65^{d}±0.02	0.0^{c}±0.0	83.35^{a} ± 0.41
WBFb	14.01^{a}±0.08	14.49^{a}±0.14	2.81^{a}±0.500	94^{c}±0.020	19^{bc}±0.04	81.76^{b} ± 0.54
WBFc	13.80^{b}±0.03	14.43^{a}±0.04	2.53^{b}±0.11	1.11^{b}±0.01	0.44^{b}±0.16	82.90^{a} ± 0.06
WBFd	13.32^{c}±0.03	14.20^{b}±0.03	2.48^{a}±0.05	1.41^{b}±0.03	0.96^{b}±0.28	81.89^{b} ± 0.05

Values followed by the same letters in the same columns are not significantly different ($P \leq 0.05$).

BPF: 100% baobab pulp flour: 0% wheat flour, WFa: 100% wheat flour: 0% Baobab fruit pulp flour

WBFb: 95% wheat flour: 5% Baobab fruit pulp flour,WBFc: 90% wheat flour: 10% Baobab fruit pulp flour

WBFd: 80% wheat flour: 20% Baobab fruit pulp flour baobab fraction. The phytochemical characteristics of composite flours were greatly enhanced by the replacement of WF with BF. In order to formulate products with high polyphenol content and thereby high antioxidant activity without using chemical additives baobab is a good choice.

Mineral contents of wheat flour and the composite flours

The levels of calcium, potassium, magnesium, iron, manganese and zinc were boosted by fortification with baobab pulp flour (Table 3). This could be a result of the high mineral content of baobab flour. The calcium content increased from 315.71 mg/100g in WFa to 734.51mg/ 00g in WBFd. The daily recommended intake of calcium is 950 mg for adults and 700 mg for children aged 4 to 6 years (NASS, 2017).

Table 3:The mineral contents of the wheat flour (WF) and the composite flours WBF

Samples	Minerals		
	macro elements		
	Ca	K	Mg
WFa	315.71	18.2	137.29
WBFb	454.32	161.31	233.45
WBFc	517.64	198.66	488.89
WBFd	734.51	234.11	610.91
Microelements	Fe	Mn	Zn
WFa	16.71	1.94	18.67
WBFb	29.76	4.81	21.35
WBFc	51.44	5.36	22.84
WBFd	69.71	6.91	24.35

WFa: 100% wheat flour: 0% Baobab fruit pulp flour,WBFb: 95% wheat flour: 5% Baobab fruit pulp flour

WBFc: 90% wheat flour: 10% Baobab fruit pulp flour,WBFd: 80% wheat flour: 20% Baobab fruit pulp flour

Magnesium content increased by more than four times(610mg/100g) by the addition of 20% baobab flour compared to the control (137.29 mg/ 100g). Magnesium is one of the most prevalent elements in the body. Magnesium is mostly known for its calming effects in addition to having a soothing effect on the muscles, stimulating the immune system and regulating the metabolism of carbohydrates and lipids in the muscular, cardiac, and neurological tissues.It also aids in the battle against stress (NASS, 2017). Magnesium shortage can result in elevated blood pressure, tachycardia, headaches, cramps and contractures of the muscles. The daily recommended dose for children is 6 mg /kg of body weight. The high magnesium level found in different composite flours (WBF) may be related to the high magnesium content in baobab flour.The potassium content increased from18.2 mg/100g to 234.11mg/100 g after the addition of 20% baobab pulp flour (Table 3). The addition of baobab flour in the formulation resulted in an increase in the potassium content of the composite flour.

The greater quantity of potassium in baobab flour as compared to wheat floure may be the cause of the increase in the potassium content with higher inclusion of baobab flour according to Reynolds *et al*. (2020). The potassium level of WBFd was lower than the value reported by Mounjouenpou *et al*. (2018). Potassium needed for the control of cell water balance, utilization of carbohydrates, and protein synthesis. It works to prevent cardiac rhythm disturbance and interferes with the cell's osmotic pressure control. Potassium has a function in muscle contraction (increased neuromuscular excitability), membrane transfer, enzyme activation and more. The most typical sign of a potassium shortage is fatigue. Hypokalemia can cause muscular weakness, myalgia and cramps. Additionally, noted are nausea, constipation, and intestinal bloating EUFIC, (2006). Our findings show that potassium is likewise the nutrient that is most prevalent in composite flours with various BF proportions. It was obvious that calcium (Ca) and potassium (K) composition of the composite flours would be improved by the partial replacement of WF with BF. These findings agree with that mentioned by Mounjouenpou,(2018) and Barakat,(2021).

Trace elements

Wheat flour containing 20% baobab flour was extremely high in iron content (69.71 mg/100 g) as compared to the control(16.71 mg/100 g) (Table 3). Iron plays a crucial role in the production and operation of haemoglobin, a protein found in red blood cells that carries oxygen from the lungs to the cells. Iron deficiency causes anemia because it affects the structure of myoglobin. The body needs 100g of enhanced baobab pulp flour daily to get the recommended 16mg of iron for women, 14mg for men and 10mg for kidsNASS, (2017). The baobab fruit is likely to be responsible for this high iron level. The iron content of cookies made with sorghum and 20% baobab pulp was much higher than that of cookies made from red animal flesh (3.7 mg/100 g).

Wheat flour enriched with baobab pulp differed considerablyin zinc content compared with the control.This content equated to 9% of the daily amount (11 mg/day for adults, maximum) asadvised by the Codex Alimentarius (2007). Numerous disorders including sterility and night blindness, are caused by zinc deficiency. Zinc level in the fortified wheat with baobab flour was greater than that in the sorghumcookies with orange-coloured potatoflour(Songre *et al,*2016). Manganese is a necessary trace element that cannot be synthesized by the organism.The addition of baobab flour increased Mn content from 1.94mg/100g in the control (WFa) to 6.91mg/100g in the WBFd (more than three times) (Table 3). Inadequate manganese intake can result in dermatitis and other dermatological issues including development retardation.

The outcomes of data presented here confirm that WF enhanced with BF within the range of 5-20% modify the macro and microelement profile with considerably higher calcium, magnesium, and iron content and thereby enhance the nutritional profile and the desired health features Kamanula *et al,* (2018). The rise in the mineral content could be ascribed to abundant sources of these minerals in baobab flour(Agu *et al,* 2020).

Amino acids of wheat flour and the composite flour

As a consequence, the amino acids (AAs) profile was improved as a result of the partial replacement of WF with BPF, enriching essential amino acids (EAAs) more than non-essential amino acids (NEAAs). However, comparing the content of individual EAAs and NEAAs between WF and partial substitution of WF with BPF revealed that most EAA and NEAA contents in WBF were higher than their content in WF, except threonine, glutamic, leucine and tyrosine that were higher in WF than in WBF (Table 4). Remarkably, lysine and valine, as the most deficient EAAs, in particular, were compensated with increasing BPF level. Regarding the amino acid makeup, our findings revealed that the inclusion of BPF resulted in an alteration of the amino acid composition in the composite flour, specifically in relation to essential amino acids (Table 4).The examined AA profile in the present research was closely linked to that of Osman,(2004) who mentioned that the sulfur-containing amino acids were found in minimal quantities in baobab pulp flour.

Table 4:Amino acid profile of wheat flour (control) and its composite with BPF

Amino Acid	Amino Acid(AA) mg\g protein			
	WFa	WBFb	WBFc	WBFd
Threonine	99.05	88.16	47.63	55.85
Valine	10.62	12.32	62.71	24.15
Isoleucine	38.66	35.55	71.49	73.57
Leucine	90.63	56.28	35.96	75.65
Phenylalanine	45.84	107.53	142.32	64.27
Lysine	34.77	35.24	96.58	57.70
Histidine	59.94	87.29	50.57	74.13
Cysteine	7.24	4.55	14.67	6.75
Methionine	34.77	35.24	96.58	57.50
NEAA				
Aspartic acid	82.92	86.44	82.41	63.44
Glutamic acid	237.62	168.99	64.90	125.92
Serine	20.84	32.70	28.79	54.78
Glycine	14.09	24.57	11.93	28.06
Arginine	44.94	61.98	41.77	40.47
Alanine	25.38	57.83	34.77	62.28
Proline	10.20	16.40	49.20	53.28
Tyrosine	71.60	48.60	39.75	37.36

WFa: 100% wheat flour: 0% Baobab fruit pulp flour, WBFb: 95% wheat flour: 5% Baobab fruit pulp flour

WBFc: 90% wheat flour: 10% Baobab fruit pulp flour,WBFd: 80% wheat flour: 20% Baobab fruit pulp flour

The sensory evaluation of biscuits

Table (5) shows the mean sensory scores of biscuits made using wheat flour (WFa) and different ratios of baobab pulp composite flours. It was obvious that the inclusion of baobab pulp flour significantly($P \leq 0.05$) affected the sensory qualities of the products. Appearance and colour are very important sensory attributes for any food because of their influence on acceptability. Biscuit samples made from a composite of wheat flour and 5% baobab flour were very acceptable by the panelists and had mostly more comparable scores to the control (WFa) followed by the addition of 10%and finally the addition of 20% baobab flour. Figure (2): representing biscuit samples obtained from 100% WF and from composite flour (WBF).Sample WBFd

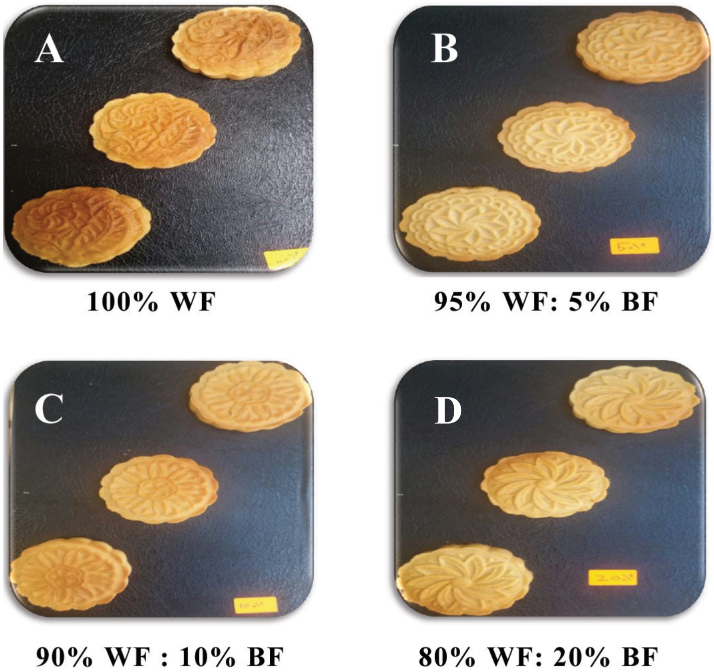

Fig. 2: The pictorial outcomes of different biscuit samples obtained from 100% WF and from a composite flour(WBF)

(20% substitution) received the lowest appearance score, while sample WBFb (5% substitution) received the highest.

The visually represented appearance indicated that the panelists preferred the sample with a light colour (sample WBFb and WBFc).The Maillard reaction, which is a reaction between sugars, proteins, amino acids, or caramelization, and intense heating during processing (Ubbor & Akobundu, 2009), may have contributed to the biscuit's browning appearance. As the amount of BPF increased, the biscuit's appearance was less accepted. The texture of the blends of biscuits and the zero baobab biscuits differed significantly ($P<0.05$).Samples WFa to WBFd had varying levels of overall acceptability, WBFb was the most accepted blend, while Sample WBFd was the least accepted (Table 5). Because organic acids such as citric, tartaric, malic, succinic, and ascorbic acid are present in baobab pulp, it is acidic (Airan & Desai, 1954**),** which is most likely the reason panelists preferred 5% BPF (sample WBFb).The 20% BPF addition had the maximum concentration of nutrients, while the 5% BPF addition had the lowest.

Sensory assessment of crackers

Table (6) shows that WFa and WBFb samples got the highest scores of consumer acceptability, followed by WBFc and then WBFd (which was the least acceptable).WBFb was very compa-

Table 5: Sensory evaluation of biscuit samples

Parameter	Organoleptic Attributes					
	Appearance	Colour	Odour	Taste	Texture	Overall
WFa	$8.05^{b}\pm0.94$	$7.70^{b}\pm0.73$	$8.65^{a}\pm0.48$	$8.55^{a}\pm0.51$	$8.60^{a}\pm0.47$	$8.0^{ab}\pm0.72$
WBFb	$8.70^{a}\pm0.47$	$8.15^{ab}\pm0.81$	$8.20^{a}\pm0.59$	$8.10^{b}\pm0.64$	$8.10^{b}\pm0.64$	$8.22^{a}\pm0.49$
WBFc	$8.65^{a}\pm0.48$	$8.35^{a}\pm0.48$	$7.60^{b}\pm0.86$	$7.25^{c}\pm0.89$	$7.65^{c}\pm0.65$	$7.77^{b}\pm0.71$
WBFd	$8.0^{b}\pm1.25$	$7.50^{b}\pm0.98$	$7.35^{b}\pm0.97$	$7.0^{c}\pm0.79$	$7.35^{c}\pm0.97$	$6.97^{c}\pm0.95$

Values followed by the same letters in the same columns are not significantly different ($P\leq 0.05$).
WFa: 100% wheat flour: 0% Baobab fruit pulp flour, WBFb: 95% wheat flour: 5% Baobab fruit pulp flour,
WBFc: 90% wheat flour: 10% Baobab fruit pulp flour, WBFd: 80% wheat flour: 20% Baobab fruit pulp flour

Table 6: Sensory evaluation of cracker samples.

Parameter	Organoleptic Attributes					
	Appearance	Colour	Odour	Taste	Texture	Overall
WFa	$8.87^{a}\pm0.13$	$8.40^{a}\pm0.73$	$8.50^{a}\pm0.60$	$8.15^{ab}\pm0.46$	$8.45^{a}\pm0.60$	$8.45^{a}\pm0.45$
WBFb	$8.55^{ab}\pm0.51$	$8.32^{a}\pm0.78$	$8.17^{ab}\pm0.65$	$8.47^{a}\pm0.78$	$8.40^{a}\pm0.73$	$8.40^{a}\pm0.73$
WBFc	$8.05^{b}\pm0.82$	$8.0^{a}\pm0.84$	$7.90^{b}\pm0.71$	$7.75^{b}\pm0.83$	$8.07^{b}\pm0.86$	$7.90^{b}\pm0.75$
WBFd	$7.55^{c}\pm1.13$	$7.40^{b}\pm0.99$	$7.32^{c}\pm1.02$	$6.65^{c}\pm1.40$	$7.95^{b}\pm0.82$	$7.0^{c}\pm0.82$

Values followed by the same letters in the same columns are not significantly different ($P\leq 0.05$).
WFa: 100% wheat flour: 0% Baobab fruit pulp flour,WBFb: 95% wheat flour: 5% Baobab fruit pulp flour,
WBFc: 90% wheat flour: 10% Baobab fruit pulp flour,WBFd: 80% wheat flour: 20% Baobab fruit pulp flour

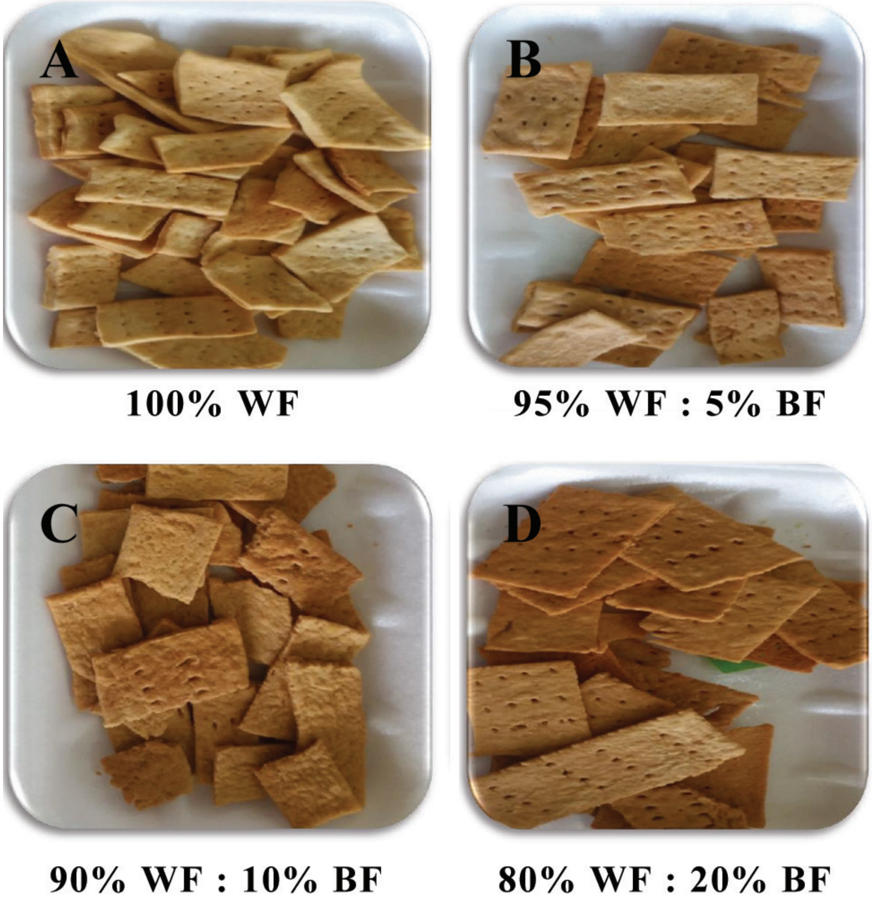

Fig. 3: The pictorial outcomes of different cracker samples obtained from wheat flour (A) and composite flour (WBF). B ⟶ D

rable to WFa (no significant difference in all quality attributes,although there was asignificant differences compared to WBFc and WBFd in all these attributes). Figure 3: representing crackers samples obtained from 100% WF and from composite flour (WBF).

CONCLUSION

Integrating BPF in WF augmented the levels of both macro and micro-nutrients. To enhance the value of the baobab fruit, it can be efficiently utilized to enhance the nutritional value of staple foods. The enhancement in iron and zinc bioavailability by baobab fruit pulp is likely attributed to itshigh content of mineral bioavailability-boosting organic acids like ascorbic acid and citric acid. Baobab-enriched biscuits serve as a substitute and easily obtainable treat for both kids and grown-ups and could be utilized in the disorders caused by lack of calciu

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إعداد وتقييم الدقيق المركب من القمح والباوباب واستخدامه لانتاج البسكويت والمقرمشات

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هدفت هذه الدراسة إلى الاستعاضة جزئيا عن دقيق القمح (WF) بدقيق الباوباب (BF) لإنتاج الدقيق المركب (WBF) وكانت نسب الاستبدال ٥٪ و ١٠٪ و ٢٠٪. لتصنيع البسكويت والمقرمشات. أظهرت نتائج التحليل التقريبي زيادة معنوية (P≤0.05) في الرماد من ٠,٩٤ إلى ١,٤١٪ ، والألياف من ١٩,٠ إلى ٩٦,٠٪، والمستخلص الخالي من النيتروجين ٨١,٧٦ إلى ٨١,٨٩ ، بينما انخفضت الرطوبة من ١٤,٠١ إلى ١٣,٣٢٪ ، بروتين من ١٤,٤٩ إلى ١٤,٢٠٪، والدهون من ٢,٨١ إلى ٢,٤٨٪ مع ارتفاع مستوى استبدال الـ BF .

الخواص ا لكيميائية النباتية للدقيق المركب؛الموادالفينولية من ٥٢,٠٤ إلى ١١١,٦١mg، والنشاط المضاد للأكسدة من ٥٢,٦٦ إلى ٧٧,١٣ المقدر بواسطة طريقة DPPH. زادت مع زيادة مستويات (BF) احتوى الدقيق المركب على كميات أعلى بكثيرمن العناصرالمعدنية التالية: Ca وK وMg وFe وMn وZn مقارنة بالمجموعة الضابطة (WF).

علاوة على ذلك، أظهر WBF كميات أعلى من الفينيل ألانين والهيستيدين على عكس الليوسين والسيستين مقارنة بـWF كعنصر تحكم. أشار التقييم الحسي إلى أن نسب الاستبدال ٥٪ كانت معنوية (P ≤ 0.05) قابلة للمقارنة مع المجموعة الضابطة كما حكم عليها أعضاءاللجنة. استبدال دقيق القمح مع BF بنسبة تصل إلى ٢٠٪ عززب شكل كبير جودته الغذائية.