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PROXIMATE, MINERAL, AMINO ACID, AND SENSORY ASSESSMENT OF CHICKPEAS-FORTIFIED PAN BREAD

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ABSTRACT

This study investigates the nutritional, sensory, and color characteristics of pan bread partially substituting wheat flour (72% extraction rate) with Kabuli chickpea powder at various levels (B1–B4). Proximate analysis revealed that chickpeas powder contains significantly higher levels of crude protein (24.50%), fat (6.80%), Crude fiber (4.90%), and ash (3.70%) compared to wheat flour, while wheat flour had greater available carbohydrates (85.85%) and moisture content (14.25%). Chickpeas powder meanwhile exhibited superior mineral content, notably in potassium (890.20 mg/100g), calcium, magnesium, and iron, supporting its role as a nutrient-dense ingredient. Amino acids profiling showed that chickpea powder provided higher levels of essential amino acids, particularly lysine, threonine, and histidine, contributing to improved Crude protein quality indices such as computed protein efficiency ratio (C-PER = 2.45) and biological value (BV = 75.69), compared to wheat flour (C-PER = 2.03 and BV = 71.27). Chemical analysis of the chickpeas-enriched bread indicated a significant increase in crude protein (up to 15.35%), Crude fiber (2.17%), fat (6.40%), and ash (1.76%) with increasing chickpeas levels, while available carbohydrates decreased

from 83.91% to 74.32%. Despite these compositional shifts, the energy values remained relatively stable across treatments. Sensory evaluation showed that increasing chickpeas levels slightly reduced scores for crust color, crumb texture, symmetry, taste, and aroma, although all blends remained within acceptable sensory quality. Colorimetric analysis revealed a darkening effect and increased redness and yellowness in both crust and crumb with higher chickpea content, attributed to Maillard reactions and chickpea pigmentation. Overall, the incorporation of Kabuli chickpea powder significantly enhanced the nutritional quality of pan bread, particularly in Crude protein, fiber, minerals, and amino acids profile, with acceptable changes in sensory and visual properties. These findings support the use of chickpea powder as a functional ingredient in bread formulations to improve their health benefits.

Keywords: Pan Bread, Chickpeas, Color, Amino Acids.

INTRODUCTION

Malnutrition and food insecurity affect billions of people globally. While the United Nations aims to eradicate hunger by 2030, we are still a long way from reaching this goal. Even after the past decade, food security has been significantly challenged by climate change, growing populations, and economic instability. Numerous nations are simultaneously tackling the problems of undernourishment and overnutrition. A complete overhaul of the food system is essential to ensure food and nutrition security (**FAO, 2023)**.

Among macronutrients, protein appears to be the most deficient. Globally, approximately one billion individuals suffer from insufficient protein consumption **(Ghosh *et al*., 2012)**, with protein malnutrition affecting 10%: 30% of children in central Africa and South Ashia **(Grover and Ee, 2009).** It is crucial to develop novel, plant-based, protein-rich food options as alternatives.

Cereals and pulses serve as crucial sources of starch, fiber, and protein in human nutrition. However, pulse consumption is restricted to specific regions and cultures, unlike cereals **(Alizadeh and da Silva, 2013)**.

Triticum aestivum L., commonly referred to as wheat, is the world's most important cereal crop, forming a dietary staple for the majority of the global population. This polyploid species is cultivated extensively in almost all regions. Wheat supplies nearly half of the total caloric intake worldwide and is a valuable source of proteins (notably gluten), essential minerals (such as copper, magnesium, zinc, phosphorus, and iron), B-complex and vit E, as well as riboflavin, niacin, thiamine, and fiber. The seed storage protein in wheat flour not only serves as a major nutritional and energy source but also plays a key role in determining bread-making quality **(Khalid *et al*., 2023)**. *Cicer arietinum* L., commonly known as chickpeas, is a yearly pulse crop belonging to the legume family. It grows from herbaceous plants that produce pods and thrives in regions with semi-arid or temperate climates **(Wrigley *et al*., 2016)**.

Recently, chickpeas have gained popularity and are being incorporated into various food preparations. This is due to their high protein digestibility and rich content of proteins, carbohydrates, B vitamins, and minerals **(Chang *et al*., 2012)**. Among legumes, chickpeas are notable for their high content of protein, dietary fiber, specific vitamins (including thiamine, niacin, and ascorbic acid), essential minerals (such as calcium, iron, potassium, magnesium, and phosphorus), unsaturated fatty acids (linoleic and oleic), and essential amino acids absent in wheat flour. **(Zafar *et al*., 2015)**. Chickpea flour, being rich in protein, fiber, minerals, and bioactive compounds, can be utilized to enhance the nutritional profile of baked goods such as bread and biscuits **(Man *et al.*, 2015)**.

This study aimed to evaluate the chemical composition, mineral content, amino acid profile, and color characteristics of wheat flour, kabuli chickpeas, and their blends, as well as to assess their use in

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producing pan bread with enhanced nutritional value and desirable sensory qualities.

MATERIALS AND METHODS

Materials

Wheat flour (72% extraction) acquired from Tanta City, Egypt's Delta Middle and West Milling Company. Chickpea (*Cicer arietinum*) and other pan bread-making components, such as baking powder, table salt (NaCl), and butter, were acquired from a local market in Damanhour, Egypt.

Methods

Chemical analysis

The crude protein, moisture, ash, crude fiber, and ether extract contents of pearl millet powder, chickpea powder, and pan bread were determined following the procedures outlined by **AOAC (2012)**.

Determination of carbohydrates

The carbohydrate content was calculated by subtracting the sum of other components from the initial sample weight, as outlined in **(AOAC, 2012)**.

Available Carbohydrates (%) = 100 %– (Crude protein % + ash % + fat % + crude fiber %).

The total carbohydrate content was determined by difference using the following formula:

Total carbohydrates = 100 - (Crude protein % + fat % + ash %).

Energy value

As stated by **James (1995)**, the energy value was calculated using the formula: energy value = 9.1 (% fat) + 4.1 (% available carbohydrates + % crude protein).

Determination of minerals

The levels of Ca, Na, Mg, Mn, K, Fe, P, and Zn were determined according to the procedures described in **(AACC, 2000)**.

Determination of amino acid composition

The amino acid content was evaluated in line with **(AOAC, 2012)** at the National Research Center, Giza, Egypt. This analysis focused on wheat flour (72% extraction) and chickpea powder.

Protein quality measurements

The protein quality of biscuits was evaluated using the following methods:

The Protein efficiency ratio (PER) was projected using the equation reported by **Alsmeyer *et al.* (1974)**:

C-PER = -0.4687 + 0.454 (Leucine) - 0.105 (Tyrosine).

Biological value (BV)

BV was calculated using the comparison described by **Farag *et al.* (1996)**: BV = 49.9 + 10.53 C-PER.

Pan bread processing

Pan bread was produced following the straight dough method described by **El-Hadidy (2020)**. The basic formulation included 100g wheat flour, 1.5 g instant active dry yeast, 2 g salt, 2 g sugar, 3 g shortening, and water. In blends 1, 2, 3, and 4, chickpea powder was incorporated at 10%, 20%, 30%, and 40% levels, respectively, as a partial substitute for wheat flour. All ingredients were mixed in a bowl at 28 °C for 6 minutes, after which the dough was manually folded 20 times to shape it, then left to rest for 10 minutes. The dough was transferred to a lightly lubricated baking pan, proofed for 60 minutes at 30 °C and 85% relative humidity, and baked in an electric oven at 250 °C for 20 minutes. The baked loaves were cooled at room temperature (25 °C) for 60 minutes before being packed in polyethylene bags for analysis, as detailed in Table 1.

Table 1: Ingredients of the pan bread made from wheat flour (72% extra) and chickpea powder

Constituents (g)	Control	B 1	B 2	B 3	B 4
WF	100	90	80	70	60
CPP	--	10	20	30	40
Salt	2	2	2	2	2
Yeast	1.50	1.50	1.50	1.50	1.50
Sugar	2	2	2	2	2
Butter	3	3	3	3	3

WF = wheat flour, CPP = chickpea powder, Control=100g wheat flour, B1 = 90 g wheat flour + 10 g chickpea powder, B2 = 80 g wheat flour + 20 g chickpea powder, B3 = 70 g wheat flour + 30 g chickpea powder, B4 = 60 g wheat flour + 40 g chickpea powder.

Sensory properties of pan bread

Mixtures were evaluated as outlined by **(AACC, 2000).** Twenty people from the Department of Food Science and Technology, Faculty of Agriculture, Damanhour University assessed the sensory properties of pan bread mixtures. They rated overall acceptability (100), aroma (10), taste (20), crumb grain texture (20), crumb color (20), symmetry (10), and crust and color (20).

Color assessment

As described by **Brunton *et al.* (2006)**, a Hunter Lab Scan Visible colorimeter was used to measure the lightness ($L*$), redness ($a*$), and yellowness ($b*$) of prepared pan bread.

Data analysis

Statistical analysis was performed using SPSS software (version 26), and Duncan's multiple range tests were conducted at the level ($P \leq 0.05$).

RESULTS AND DISCUSSIONS

Proximate compositional raw materials (wheat flour and chickpea powder)

The compositional analysis of wheat flour (72% extraction) and Kabuli chickpea powder presented in Table 2 reveals notable differences in their nutritional profiles. Moisture content was significantly higher in wheat flour (14.25%) compared to chickpea powder (7.50%), indicating that chickpeas are drier and potentially more shelf-stable. In terms of crude protein, chickpea powder showed a markedly higher value (24.50%) than wheat flour (11.30%), emphasizing its role as a superior plant-based protein source. Fat content was also considerably greater in chickpea powder (6.80%) compared to wheat flour (1.60%), as was the crude fiber content (4.90% in chickpea vs. 0.60% in wheat), highlighting the enhanced nutritional and digestive benefits of chickpea.

Ash content, representing mineral composition, followed the same trend, being much higher in chickpea powder (3.70%) than in wheat flour (0.65%). Conversely, wheat flour had significantly higher available carbohydrates (85.85%) and total carbohydrates (86.45%) compared to chickpea powder (60.10% and 65.00%, respectively), indicating its dominance as an energy-rich carbohydrate source. Despite this, the energy values (kcal/100g) were relatively close, with

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wheat flour at 412.87 kcal and chickpea powder at 408.74 kcal, suggesting that chickpeas provide a comparable caloric value but with enhanced nutritional density, especially in protein, fat, fiber, and minerals.

These findings nearly agree with those found by **Raya *et al.* (2022)** and **Khattab *et al.* (2024)** which that the protein, fat, fiber, ash and available carbohydrates in Wheat flour were ranged (11.28 to 11.80%), (1.50 to 1.95%), (1.93 to 0.60%), (1.24 to0.55%) and (83.95 to 85.10%) respectively. The findings are in harmony with the work of **Elsaid *et al.* (2021)** and **Maray (2022)** how that the protein, fat, fiber, ash, and available carbohydrates in Kabuli chickpeas were ranged (24.73 to 24.61%), (5.60 to 5.10%), (3.91 to 4.86%), (1.96 to 2.80%) and (63.81 to 62.63%) respectively.

Table 2: The composition analysis of wheat flour and chickpea powder

Raw materials	Wheat flour 72%	Kabuli chickpea Powder
Moisture	14.25^{a}±0.15	7.50^{b}±0.04
Crude protein%	11.30^{b}±0.05	24.50^{a}±0.06
Fat%	1.60^{b}±0.03	6.80^{a}±0.03
Crude fiber%	0.60^{b}±0.01	4.90^{a}±0.02
Ash%	0.65^{b}±0.02	3.70^{a}±0.02
Available carbohydrates%	85.85^{a}±0.12	60.10^{b}±0.10
Total carbohydrates%	86.45^{a}±0.12	65.00^{b}±0.15
Energy (K100cal)	412.87^{a}±0.15	408.74^{b}±0.12

Means with different letters in the same row are significantly different at p≤ 0.05. Each value was an average of three determinations ± standard deviation.

Mineral composition of 72% extraction rate wheat flour and chickpea powder

The mineral composition data of wheat flour (72% extraction rate) and Kabuli chickpea powder illustrate significant differences in their micronutrient content. Chickpea powder demonstrated substantially higher levels of most essential minerals compared to wheat flour, indicating its superior mineral density.

Potassium (K) content was remarkably higher in chickpeas (890.20 mg/100g) than in wheat flour (125.30 mg/100g), which is beneficial for maintaining fluid balance and proper muscle function. Similarly, calcium (Ca), which is important for bone health, was recorded at 180.60 mg/100g in chickpeas versus only 23.50 mg/100g in wheat flour. Magnesium (Mg), essential for enzymatic reactions and muscle function, was also higher in chickpeas (172.30 mg/100g) compared to wheat flour (121.20 mg/100g).

Sodium (Na) content showed a significant increase in chickpea (95.50 mg/100g) compared to the low level in wheat flour (4.20 mg/100g), which may contribute to the overall electrolyte balance but needs to be considered in low-sodium diets. Phosphorus (P), crucial for energy metabolism and bone health, was present at 265.80 mg/100g in chickpea, surpassing the 186.30 mg/100g found in wheat flour.

In terms of trace elements, iron (Fe) content in chickpeas (9.50 mg/100g) was over three times that in wheat flour (2.95 mg/100g), which is significant for anemia prevention and oxygen transport. Zinc (Zn), necessary for immune function and cell division, was also higher in chickpeas (5.03 mg/100g) than in wheat flour (3.90 mg/100g). However, manganese (Mn) content was slightly higher in wheat flour (3.00 mg/100g) compared to chickpeas (2.50 mg/100g), marking it as the only mineral in which wheat flour had a slight advantage.

Overall, Kabuli chickpea powder offers a richer profile of essential minerals than wheat flour, making it a valuable ingredient in enhancing the nutritional quality of food products. These results agreed with of **Egaila *et al.* (2024)**, **Mousa (2021), El-Dreny *et al.* (2022) and Maray (2023)** that chickpea are rich in minerals that the body needs.

Table 3: The mineral contents of wheat flour and chickpea powder

Mineral	Wheat flour 72%	Kabuli chickpea powder
K	125.30^{b}±1.10	890.20^{a}±1.30
Ca	23.50^{b}±0.80	180.60^{a}±1.00
Mg	121.20^{b}±0.80	172.30^{a}±1.20
Na	4.20^{b}±0.05	95.50^{a}±0.80
P	186.30^{b}±0.80	265.80^{a}±1.50
Fe	2.95^{b}±0.01	9.50^{a}±0.02
Zn	3.90^{b}±0.02	5.03^{a}±0.01
Mn	3. 00^{a}±0.03	2.50^{b}±0.01

Means with different letters in the same row are significantly different at p≤ 0.05). Each value was an average of three determinations ± standard deviation.

The amino acids of wheat flour 72% extraction and chickpea powder

Amino acid analysis of wheat flour (72% extraction) and Kabuli chickpea powder, as presented in Table 4, highlights significant nutritional differences, particularly in terms of essential amino acids (EAA) and their alignment with the **FAO/WHO/UNU (1985)** recommended pattern.

Kabuli chickpea powder shows a considerably higher content of lysine (7.00 g/100g protein) compared to wheat flour (2.95 g/100g), surpassing the recommended level of 5.80 g. Lysine is a limiting amino acid in many cereals, so chickpeas effectively complement the amino acid profile of wheat. Isoleucine and leucine, both branched-chain amino acids important for muscle metabolism, are slightly higher in chickpeas (4.30 and 7.40 g) than in wheat (4.00 and 7.10 g), and both exceed the recommended levels (2.80 and 6.60 g, respectively).

Phenylalanine and tyrosine combined also appear higher in chickpeas (5.50 and 3.50 g) compared to wheat (4.50 and 2.60 g), and histidine, another essential amino acid, is more abundant in chickpeas (3.10 g) than in wheat (2.00 g), both exceeding the standard (1.90 g). Threonine meets the recommendation in chickpeas (3.40 g) but falls short in wheat (2.60 g), while valine is higher in wheat (4.45 g) than in chickpeas (3.20 g), though both are close to the required 3.50 g.

However, methionine and cystine sulfur sulfur-containing amino acids are relatively low in both sources, especially in chickpeas (1.50 and 1.20 g), which do not meet the FAO requirement for methionine (2.20 g), while wheat is slightly higher in cysteine (1.80 g). Tryptophan levels in both wheat (1.25 g) and chickpeas (1.15 g) meet or exceed the recommended level of 1.00 g.

In total, chickpeas contain a higher amount of essential amino acids (40.05 g) compared to wheat (34.85 g), indicating superior protein quality. However, wheat flour has a higher amount of non-essential amino acids (61.60 g) than chickpeas (54.25 g), particularly glutamic acid and proline, which are dominant in cereal proteins.

Protein quality indicators also favor chickpeas, with a higher calculated protein efficiency ratio (C-PER) of 2.45 compared to 2.03 in wheat, and a higher biological value (BV) of 75.69 versus 71.27. The findings indicate that chickpeas provide an extra balanced and comprehensive aminoacid profile, positioning them as an ideal protein complement to wheat in food formulations, particularly for overcoming the lysine and threonine deficiencies typically found in cereals.

These findings are consistent with those reported by **Egaila *et al.* (2024)**, who indicated that the wheat flour contains amino acids: 2.71 lysine, 4.10 isoleucine, 4.90 valine, 1.62 methionine, 4.23 phenylalanine, 1.03 tryptophan, 3.50 threonine, 7.80 leucine, and 2.26 histidine g per 100-gram protein in respectively. The amino acid results for chickpea powder are identical to **El-Dreny *et al*, (2022).**

Table 4: The amino acids of wheat flour 72% extraction and chickpea powder

Amino acids	Wheat flour 72%	Kabuli chickpea powder	FAO/WHO/UNU (1985) pattern
Lysine	2.95	7.00	5.80
Isoleucine	4.00	4.30	2.80
Leucine	7.10	7.40	6.60
Phenylalanine	4.50	5.50	6.30
Tyrosine	2.60	3.50	
Histidine	2.00	3.10	1.90
Valine	4.45	3.20	3.5
Threonine	2.60	3.40	3.40
Methionine	1.60	1.50	2.20
Tryptophan	1.25	1.15	1.00
Cysteine	1.80	1.20	-
Total (EAA)	34.85	40.05	-
Aspartic acid	5. 10	10.95	-
Glutamic acid	29.00	15.80	-
Serine	4.50	4.70	-
Proline	11.00	5.00	-
Glycine	4.90	4. 00	-
Alanine	3.00	4.60	-
Arginine	4.10	9.20	-
Total (NEAA)	61.60	54.25	-
C-PER	2.03	2.45	-
BV	71.27	75.69	-

EAA: Essential amino acids, NEAA: Non essential amino acids, C-PER = Computed protein efficiency ratio, BV = Biological value

Proximate composition of pan bread made from wheat flour 72 % and Kabuli Chickpea powder blends.

The chemical composition of pan bread supplemented with varying levels of chickpea powder (B1, B2, B3, and B4) is presented in Table 5. Significant changes were reported compared to the control. As the level of chickpea powder increased, there was a consistent and significant enhancement in the nutritional content of the bread. Crude protein content increased from 10.46% in the control to 15.35% in B4, indicating the high protein contribution of chickpea powder. Similarly, fat content rose progressively from 4.48% in the control to 6.40% in B4, and crude fiber increased from 0.55% to 2.17%, suggesting improved dietary fiber availability. Ash content, which reflects the mineral content, also increased from 0.60% in control to 1.76% in B4.

Table 5: Chemical composition of pan bread supplemented with dissimilar levels of chickpea powder.

Parameter	Control	B 1	B 2	B 3	B 4
Crude protein%	10.46^{e} ±0.0 2	11.68^{d} ±0.03	12.90^{c} ±0.05	14.12^{b} ±0.04	15.35^{a} ±0.01
Fat%	4.48^{e} ±0.04	4.96^{d} ±0.01	5.53^{c} ±0.03	5.92^{b} ±0.04	6.40^{a} ±0.06
Crude fiber%	0.55^{e} ±0.02	0.99^{d} ±0.01	1.38^{c} ±0.02	1.78^{b} ±0.04	2.17^{a} ±0.02
Ash%	0.60^{e} ±0.01	0.92^{d} ±0.03	1.20^{c} ±0.05	1.47^{b} ±0.07	1.76^{a} ±0.05
Available carbohydrates%	83.91^{a} ±0.08	81.15^{b} ±0.05	78.99^{c} ±0.10	76.61^{d} ±0.09	74.32^{e} ±0.07
Total carbohydrates%	84.46^{a} ±0.05	82.14^{b} ±0.17	80.37^{c} ±0.007	78.49^{d} ±0.20	76.49^{e} ±0.10
Energy (K /100cal)	427.68^{b} ±0.09	425.73^{e} ±0.05	427.07^{a} ±0.02	425.86^{d} ±0.05	425.88^{c} ±0.06

Means with different letters in the same row are significantly different at p≤ 0.05). Each value was an average of three determinations ± standard deviation.

Conversely, available carbohydrates decreased from 83.91% in the control to 74.32% in B4, and total carbohydrates followed a similar declining trend, from 84.46% to 76.49%. This decrease is likely due to the substitution of carbohydrate-rich wheat flour with chickpea flour, which is higher in protein and fiber. Interestingly, the energy value of the bread did not show a proportional increase despite the rise in protein and fat content. The highest energy value was observed in sample B2 (427.07 kcal), while the lowest was in B1 (425.73 kcal), showing minimal fluctuation across all treatments. This suggests that chickpea supplementation modifies the macronutrient composition without significantly altering the overall caloric content. Overall, the incorporation of chickpea powder improved the nutritional profile of pan bread, especially in terms of protein, fiber, and mineral content, while slightly reducing carbohydrate levels. These results are identical to **Felisiak *et al.* (2024)**.

Sensory properties of pan bread made

The sensory evaluation data in Table 6 show clear variations in the quality attributes of pan bread produced from different blends when compared to the control sample (100% wheat flour). The control consistently achieved the highest scores across all sensory criteria—crustcolor (19), crumbcolor (19), crumbgrain texture (19), symmetry (10), taste (20), and aroma (10)—reflecting excellent overall sensory suitability. As chickpea or other ingredients were incorporated in increasing proportions across the blends (Blend 1 to Blend 4), a progressive decline in sensory scores was observed. This is consistent with the results **(Gadallah and Aljebreen, 2023).**

For instance, crust and crumb color scores decreased from 18.5 in blend 1 to 16 in blend 4, reflecting a darker or less appealing color as substitution increased. Similarly, crumb grain texture declined from 18 in blend 1 to 15 in blend 4, suggesting that higher substitution levels negatively impacted the bread's internal structure. Symmetry, an indicator of loaf shape and uniformity, dropped steadily from 9.5 in blend 1 to 7 in blend 4. Taste and aroma—two of the most critical factors for consumer acceptance also showed a gradual reduction. The taste score decreased from 19 in blend 1 to 18 in blends 3 and 4, while aroma followed a similar trend, dropping from 9.5 to 8.

Color characteristics of pan bread

Table 7 shows the crust and crumb color characteristics of pan bread prepared with 72% extraction wheat flour and different proportions of chickpea powder, assessed using the CIELAB color parameters: *L** (lightness), *a** (red-green), and *b** (yellow-blue). For crust color, the control sample (100% wheat flour) had the highest lightness value (*L** = 63.09), indicating a lighter crust compared to the chickpea blends. As the proportion of chickpea powder increased from blend 1 to blend 4, the *L** values progressively decreased (down to 51.55 in blend 4), reflecting a darker crust. Simultaneously, the *a** values (indicating redness) and *b** values (indicating yellowness) increased, with blend 4 showing the highest a* (22.39) and *b** (43.30) values. This suggests that chickpea incorporation intensifies the red and yellow tones of the crust, likely due to Maillard reactions and pigment content in chickpeas **Vidal-Valverde *et al.* (2003).**

Regarding the crumb color, a similar trend is observed. The control sample had the highest lightness (*L** = 69.90) and lower redness (*a** = 3.51) and yellowness (*b** = 18.77). As chickpea content increased, lightness decreased noticeably (down to 57.43 in blend 4), while both *a** and *b** values increased—most notably the *b** value, which reached 28.94 in blend 4. Notably, blend 3 showed a significantly higher redness value (*a** = 11.28), indicating a marked shift in color intensity due to chickpea addition.Overall, the incorporation of chickpea powder into wheat flour affects the color characteristics of pan bread, resulting in darker, more reddish, and yellowish tones in both crust and crumb. These changes may influence consumer perception, as color is a key indicator of quality and flavor expectations **Khattab *et al.* (2024)**.

Table 6: Sensory properties of pan bread

Blends	Crust color (20)	Crumb color (20)	Crumb grain texture (20)	Symmetry (10)	Taste (20)	Aroma (10)
Control	19.0^{a}±0.20	19.0^{a}±0.05	19^{a}±0.10	10.0^{a}±0.05	20.0^{a}±0.05	10^{a}±0.10
Blend (1)	18.5^{b}±0.15	18.5^{b}±0.10	18^{b}±0.14	9.5^{b}±0.20	19.0^{b}±0.20	9.5^{b}±0.15
Blend (2)	18.0^{c}±0.10	17.5^{c}±0.14	17^{c}±0.10	9.0^{c}±0.09	18.5^{c}±0.10	9.0^{c}±0.08
Blend (3)	17.0^{d}±0.20	17.0^{d}±0.12	16^{d}±0.02	8.0^{d}±0.05	18.0^{d}±0.09	8.5^{d}±0.09
Blend (4)	16.0^{e}±0.13	16.5^{e}±0.10	15^{e}±0.09	7.0^{e}±0.10	18.0^{d}±0.08	8.0^{e}±0.05

Means in the same column with different letters are significantly different ($p \leq 0.05$). Each mean value is followed by ± SD (standard deviation).

Table 7: Color characteristics of pan bread prepared from wheat flour (72% extr) and chickpea powder: -

Blend	Crust color			Crumb color		
	L*	***a****	***b****	***L****	***a****	***b****
Control	63.09^{a} ±0.01	17.38^{d} ±0.01	34.52^{d} ±0.01	69.90^{a} ±0.01	3.51^{e} ±0.01	18.77^{e} ±0.01
Blend (1)	55.35^{b} ±0.01	20.33^{b} ±0.01	40.16^{b} ±0.01	67.56^{b} ±0.01	4.57^{c} ±0.01	21.55^{d} ±0.01
Blend (2)	54.27^{c} ±0.01	14.26^{e} ±0.01	32.40^{e} ±0.01	61.62^{c} ±0.01	4.45^{d} ±0.01	23.36^{c} ±0.01
Blend (3)	53.22^{d} ±0.01	19.75^{c} ±0.01	37.91^{c} ±0.01	58.76^{d} ±0.01	11.28^{a} ±0.01	28.28^{b} ±0.01
Blend (4)	51.55^{e} ±0.01	22.39^{a} ±0.01	43.30^{a} ±0.01	57.43^{e} ±0.01	5.95^{b} ±0.01	28.94^{a} ±0.01

Means in the same column with different letters are significantly different ($p \leq 0.05$). Each mean value is followed by ± SD (standard deviation)

CONCLUSION

This study highlights the nutritional and functional advantages of incorporating Kabuli chickpea powder into wheat flour (72% extraction) for pan bread production. Chickpea powder significantly improves the bread's content of protein, fat, fiber, minerals, and essential amino acids, especially lysine and threonine, making it a nutritionally superior ingredient. While overall energy content remains stable, available carbohydrates decrease as chickpea levels increase. Sensory and color attributes slightly decline with higher substitution levels, particularly beyond Blend 3. Therefore, moderate inclusion (up to Blend 2 or 3) is recommended to enhance nutritional value while preserving consumer acceptability.

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REFERENCES

AACC (2000). Approved Methods of American Association of Cereal Chemists. Published by American Association of Cereal Chemists, Inc. St. Paul, Minnesota, USA.

Alizadeh, K., da Silva, J.A.T. (2013). Mixed cropping of annual feed legumes with barley improves feed quantity and crude protein content under dry-land Conditions. Maejo International Journal of Science and Technology, 7(1), 42-47.

Alsmeyer R.H., Cuningham A.E., Happich, M.L. (1974) Equations predict PER from amino acid analysis. Food Techno., 28 (7) 34-40. 22.

AOAC (2012). Association of Official Analytical Chemists Official Methods of Analysis of the Association of Official Analytical Chemists. 18th edition. Gaithersburg, USA.

Brunton, N., Gormley, R., Butler, F., Cummins, E., Danaher, M., O'Keeffe, M. (2006). Acrylamide Formation in Potato Products. Ashtown Food Research Centre, Dublin, 15.

Chang Y.W., Alli I., Molina A.T., Konishi Y., Boye J.I. (2012). Isolation and characterization of chickpea (*Cicer arietinum* L.) seed protein fractions. Food Bioprocess Technol.; 5:618–2.

Gadallah, M.G., Aljebreen, A.A. (2023). Effect of solid-state fermentation on the nutritional value of chickpea flour and physicochemical, antioxidant activity and sensory evaluation of pan bread. Alexandria Science Exchange Journal, 44(2), 135-145.

Egaila, A., Kassabb, H., Abdelrasoul, E., Own, M. (2024). Improving the Quality of Wheat Rusk using Chia Seeds (*Salvia hispanica* L.). Egyptian Journal of Chemistry, 67(10), 61-69.

El-Dreny, E.G., Marwa, M., Ekram, H. (2022). Utilization of millet for the preparation of high nutritional foods for gluten allergy Patients Journal of Sustainable Agricultural Science.

El-Hadidy, G.S. (2020). Preparation and Evaluation of Pan Bread Made with Wheat Flour and Psyllium Seeds for Obese Patients. Journal Current Science International, 9(2), 369-380.

El-Said, E.T., Soliman, A.S., Abbas, M.S., Aly, S.E. (2021). Treatment of anaemia and malnutrition by shamy bread fortified with spirulina, quinoa and chickpea flour. Egyptian Journal of Chemistry, 64(5), 2253-2268.

FAO, IFAD, UNICEF, WFP, WHO (2023). The State of Food Security and Nutrition in the World 2023 .Urbanization, agri-food systems transformation and healthy diets across the rural–urban continuum. Rome. https://doi.org/10.4060/cc3017en

Farag, S.A., Nassef, A.E., El-Shirbeeny, A. (1996). Physiochemical studies for preparing quick-cooking rice using gamma irradiation. Annals of Agricultural Science, Moshtohor (Egypt), 34(2).

Felisiak, K., Przybylska, S., Tokarczyk, G., Tabaszewska, M., Słupski, J., Wydurska, J. (2024). Effect of Chickpea (*Cicer arietinum L.*) Flour Incorporation on Quality, Antioxidant Properties, and Bioactive Compounds of Shortbread Cookies. Foods, 13(15), 2356.

Ghosh, S., Suri, D., Uauy, R. (2012). Assessment of protein adequacy in developing countries: quality matters. British Journal of Nutrition, 108(S2), S77-S87

Grover, Z., Ee, L.C. (2009). Protein energy malnutrition. Pediatric Clinics, 56(5), 1055-1068.

James, W. (1995). The moral equivalent of war. Peace and conflict, 1(1), 17-26.

Khalid, A., Hameed, A., Tahir, M.F. (2023). Wheat quality: A review on chemical composition, nutritional attributes, grain anatomy, types, classification, and function of seed storage proteins in bread making quality. Frontiers in Nutrition, 10, 1053196.

Khattab, M.E., Elanany, A.M., El-Hadidy, G.S. (2024). Utilization of Millet, Cassava and Chickpea to Prepare High Nutrient Different Products for Celiac Patients. Asian Journal of Food Research and Nutrition, 3(4), 849-860.

Man, S., Păucean, A., Muste, S., Pop, A. (2015). Effect of the chickpea (*Cicer arietinum* L.) flour addition on physicochemical properties of wheat bread. Bulletin UASVM Food Science and Technology. 72(1): 41-49.

Maray, A.R.M. (2023). Physicochemical and functional properties, nutritional value and bioactive compounds of some composite flours. Assiut Journal of Agricultural Sciences, 54(1), 116-131.

Mousa, M.M. (2021). Processing gluten-free noodles fortified with chickpea flour. Journal of Food and Dairy Sciences, 12(9), 203-209.

Raya, A., Ghoneem, G.A., Elhadi, H.A. (2022). Effect of Addition Corn Flour on Chemical, Physical, Rheological and Sensory Properties of Iraq Bread. Journal of Food and Dairy Sciences, 13(6), 95-100.

Vidal-Valverde, C., Frias, J., Hernández, A., Martín-Alvarez, P. J., Sierra, I., Rodríguez, C., Vicente, G. (2003). Assessment of nutritional compounds and antinutritional factors in pea (Pisum sativum) seeds. Journal of the Science of Food and Agriculture, 83(4), 298-306.

Wrigley, C. W., Corke, H., Seetharaman, K., and Faubion, J. (Eds.). (2015). *Encyclopedia of food grains*. Academic Press.

Zafar, T.A., Al-Hassawi, F., Al-Khulaifi, F., Al-Rayyes, G., Waslien, C., Huffman, F.G. (2015). Organoleptic and glycemic properties of chickpea-wheat composite breads. Journal of Food Science and Technology, 52(4), 2256–2263.

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الملخص العربى

التقيم التقريبى والمعدني واللأحماض الأمينية و الحسى لخبز القوالب المدعم بمسحوق الحمص.

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تتناول هذه الدراسة الخصائص التغذوية والحسية واللونية لخبز القوالب عند استبدال جزء من دقيق القمح (استخلاص ٧٢٪) بمسحوق الحمص الكابولى بمستويات مختلفة (B1-B4) . أظهر التركيب الكيميائى ان مسحوق الحمص يحتوى على نسب عالية من البروتين الخام (٢٤,٥٠٪)، والدهون (٦,٨٠٪)، والألياف الخام (٤,٩٠٪)، والرماد (٣,٧٠٪) مقارنة بدقيق القمح، فى حين تميز دقيق القمح بارتفاع محتواه من الكربوهيدرات المتاحة (٨٥,٨٥٪)، والرطوبة(١٤,٢٥٪). كما أظهر مسحوق الحمص تفوقاً فى محتوى المعادن، خاصة البوتاسيوم (٨٩٠,٢٠ ملجم/١٠٠جم)، الى جانب الكالسيوم والمغنسيوم والحديد، مما يدعم دوره كمكون غنى بالعناصر الغذائية. اوضحت الدراسة ارتفاع محتواه من الأحماض الأمينية الأساسية وخاصة الايسين ، والثريونين، والهيستيدين ، مما ساهم فى تحسين مؤشرات جودة البروتين الخام. أظهر التحليل الكيميائى لخبز القوالب المدعم بالحمص زياده ملحوظة فى البروتين الخام ، والألياف الخام والدهن والرماد بزياده مستويات الحمص، فى حين انخفضت الكربوهيدرات ورغم هذه التغيرات فى التركيب بقيت قيم الطاقة مستقرة نسبياً عبر المعاملات المختلفة. أما التقيم الحسي فقد أظهر ان زياده مستويات مسحوق الحمص أدت الى انخفاض طفيف فى درجات لون القشرة، وملمس اللبابة، والتماثل، والطعم، والرائحة، الى ان جميع الخلطات ظلت ضمن حدود الجودة الحسية المقبولة. وأظهر التحليل اللونى تأثير فى تغميق اللون وزياده درجات الاحمرار والاصفرار فى كلاً من القشرة واللبابة مع ارتفاع محتوى الحمص .