



Production of High Nutritional Value Cupcakes for Primary Stage Children

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THIS study was carried out to develop cupcakes formulations with a novel recipe by replacement of wheat flour WF (72%) by chickpea flour (CF) alone or chickpea flour and defatted almond flour (DAF) different levels, all of them fortified by whey protein concentrate powder WPCP, and control (C) from WF with skimmed milk powder (SMP). By studying of proximate analysis of raw material, WPCP was the highest protein content (77%) followed by DAF (36%) then SMP (33%) and CF (26.5%), while DAF and CF were the highest of fat and crude fiber compared with other ingredients, SMP and WPCP were the highest of ash content followed by CF and DAF. Replacement of SMP by WPCP in F1 resulted to an increase in protein content from (7.9 %) in C to (9.5%). Further replacement of WF by CF and WPC in F2 results more increase in protein (11.25%), while replacement of WF by CF, DAF and WPC (F3 to F5) results the best increase in protein (12.5 to 15.0%). Replacement led to clear improving in fat and ash also doubling content of crude fiber, iron and zinc content and good score in calcium in samples compared with C. Amino acids fractionation of cupcakes samples were studied and found that the replacement led to improving and increasing in total essential amino acids, chemical score and biological value for samples compared with C. By studying of physical properties, (Height) there is no significant difference in height between C and F1, F2, and F3 samples, but height was decreased from 5.24 cm in C to 4.08 cm in F5 with high of replacement ratio of WF by CF and DAF, volume and specific volume were same trend, while water activity (a_w) was increased in cupcakes' samples compared with C. Replacement led to a slight decrease in the texture properties of cupcakes samples compared with C, but it's good and acceptable scores, C, F1, F2 and F3 samples were the highest scores among all sensory attributes with no significant difference, while F4 and F5 samples had few decrease in scores but good and acceptable scores. Replacement led to good improving in the nutritional value of cupcakes samples by doubling both the content of protein, crude fiber and essential minerals. It can achieve a high percentage of daily needs of children in primary stage of essential nutrients through a child-friendly product.

Keywords: Cupcakes, Chickpea, Defatted almond flour, Whey protein concentrate powder.

Introduction

Concerns concerning the creation of foods with high nutritional content are strongly related to consumers' rising demands for these foods, especially in industrialized nations where eating a balanced diet means preserving or even enhancing one's health condition (Stoin et al., 2018). Cupcakes are modern product and high nutritional values like protein, sugar, fat and minerals content.

In addition to sugar and fresh egg, a general cupcakes contains various quantities of wheat flour, sugar, fat and egg, together with baking powder, flavoring and dairy products, cupcakes are characterized by a long shelf life and can undergo changes in their components in order to provide a lot of dietary needs. Another important point in the offering of cakes is its nutritional value, considering that consumer satisfaction is decisive for the success of a newly formulated

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product, Trends in healthy food and growing progress in research into functional natural additives by replacement wheat flour in cupcakes making on industrial scale (Salehi et al., 2016; Silva et al., 2020).

Fortification of wheat flour by Legume or pulses flours are ideal ingredients for boosting the nutritional content of baked items because of their high protein content, amino acid composition and fiber content (Gomez et al., 2008). The use of legumes in bakery products is a very promising with the development in food technology. The production of various products with great nutritional content and healthy food was made by combining nuts, grains, and legumes (Galal et al., 2022).

Chickpea (*Cicer arietinum*) is a legume belonging to *Fabaceae family* and is one of the oldest and most broadly consumed legumes in the world, mainly in tropical and subtropical areas (Lev-Yadun et al., 2000; Martinez et al. 2017). It is a very important protein source, also as good source of minerals, β -carotenes, and unsaturated fatty acids (Jabeen et al., 2022). Chickpea and its flour are being widely used in food processing. It is taken into consideration as a good and inexpensive vegetarian food because of its healthy nutritional profile and medicinal properties. Its chemical composition indicates that it is a great source of proteins, amino acids, dietary fibers, carbohydrates and vitamins (de Almeida Costa et al., 2006; Ammar et al., 2022).

One of the most popular nut trees in the Mediterranean region, the United States, Australia, and China is the almond (*Prunus dulcis*) with a high quantity of protein, minerals, and unsaturated fatty acids, almonds offer a strong nutritional value. The health benefits of its fatty acid profile have been hypothesized (Andersson, 2016) Almond Residue or Almond Meal, a by-product of the extraction of almond oil, accounts for at least 50% of the mass of the original almonds (Singh et al., 2022) reported that several oilseed cakes have been utilized as a protein rich substitute (Houmy et al. 2020) reported that the almond cake is by-product from the almond oil obtaining process has high protein content, minerals, dietary fiber, and substances with still not widely used as food ingredients and can be turned into flour. It also contains considerable amounts of sugars, fiber, and proteins. Almond flour has a distinct flavor and is very soft, similar in appearance to ordinary white

flour (Granato & Ellendersen., 2009). Addition of Almond flour mix with rice flour in 20%, 40% and 60% in gluten free muffins led to improving of nutritional characteristics and increases the essential nutritional value of products. Stoin et al. (2018), and Hassan (2022) found the same results when fortified of gluten free products by almond flour.

Another by-product, whey protein, comes from the production of cheese and is found in the milk serum that is left over after the coagulum has been removed from milk or cream (Madenci & Bilgiçli, 2014). Every necessary amino acid is present in sufficient concentrations in whey proteins, which make up over 20% of milk proteins. They also contain high levels of branched-chain amino acids including lysine, isoleucine, and valine (Burrington, 2012)

The aim of this study is maximization the utilization of defatted almond flour byproduct and chickpea flour fortified by whey protein concentrate powder for produce high nutritional value with high quality protein of cupcakes for primary stage children for achieving a high percentage of Recommended Dietary Allowances of essential nutrients.

Materials and Methods

Materials

Defatted almond flour (by-product of almond oil extraction), whey protein concentrate powder and cake gel improver used in this investigation were obtained from Egyptian Company for Advanced Projects (ECAP), Nasr City, Cairo, Egypt. Wheat flour (72% extraction rate) was obtained from south Cairo Company of milling. Fresh eggs, skim milk powder, vanilla, powdered sugar, baking powder, sunflower oil, salt, and chickpeas flour were all acquired from the local market. All of the chemicals were purchased from the Scientific Office Company for Chemicals in Giza, Egypt, and were of the analytical reagent quality.

Cupcakes preparation

Cupcakes formulations in Table 1 were developed and balanced according to the procedure described by Bennion & Bamford, (1997) ; Silva et al. (2020) with some modifications. Fine sugar, fat, and cake gel improver were mixed together for five minutes at high speed. Then fresh eggs and pure Villain were added on high-speed to 5-minutes. Next, the reconstituted skim milk powder or whey protein

concentrate powder were mixed with water and added, to mix by slowly, the mixing continued for 5 min at medium speed then 1 min at high a speed arriving to the white cream phase, finally, along the wheat flour, or flour blends, salt, and baking powder were added. Finally, the mixture was combined for 5 min at a low speed. Batter was uniformed. The cupcakes batter was poured into the moulds by weight 35g and baked for 25 min at 170 °C in a forced-air rotation oven. Then cupcakes were cooled for two hr to room temperature (25 °C). The cupcakes were packaged in metalized polyethylene plastic bags, one piece per bag, finally, samples were kept for tests and evaluations.

Chemical analysis

The proximate chemical composition, i.e., moisture, crude protein, total fat and ash of raw materials and cupcake samples were determined according to (AOAC, 2010). Total carbohydrates were calculated by difference. Total calories were calculated by the formula of Jame (1995) as follows:

$$\text{Total calories (Kcal)} = \text{Fat} \times 9 + \text{Protein} \times 4 + \text{Carbohydrates} \times 4$$

For mineral analysis, microwave digester (Multiwave GO Plus 50 HZ) was used prior to spectrophotometric analysis of the samples by MPAES (Microwave Plasma -Atomic Emission

Spectroscopy) (Agilent, Mulgrave, Victoria, Australia) as described by Helal &Nassef (2021).

Determination of amino acid profile of cupcakes

The produced cupcakes were subjected to hydrolysis using HCL (6 N) at 110C for 24 h. The acid was evaporated and the residue was dissolved in buffer (pH 2.2). The soluble amino acids were fractionated and determined using Amino Acid Analyzer (Biochrom 30) according to the method outlined in AOAC (2010). Then, the chemical score of essential amino acids (EAA) was relatively calculated according to (FAO/WHO, 2007) using the following equation:

$$\text{Chemical score (\%)} = \frac{\text{EAA in crud protein sample} \times 100}{\text{EAA of FAO /WHO}}$$

Biological value of the cupcakes was calculated according to (Eggam el al., 1979) as follows:-

$$\text{Biological value\%} = 39.55 + 8.89 \times \text{lysine (g/100g protein)}$$

Physical properties for cupcakes

Cupcakes weight (g) was recorded after cooling for 1hr. Cupcake height was measured to the nearest millimeter with a micrometer. Weight (g) and volume (cm³) was measured by seed displacement was determined according to (AACC, 2010). Specific volume (cm³/g) of cupcake was calculated by dividing volume by weight.

TABIE 1. Cupcakes formulations

	Control	F1	F2	F3	F4	F5
Wheat Flour (72%)	35	35	25	20	15	10
% Defatted Almond Flour	-	-	10	10	10	10
Chickpea Flour %	-	-	-	5	10	15
Skimmed milk powder	4.0	-	-	-	-	-
Whey protein concentrate %	-	4	4	4	4	4
powdered Sugar%	25	25	25	25	25	25
Fresh Egg%	25	25	25	25	25	25
Shortening%	8.0	8.0	8.0	8.0	8.0	8.0
Corn oil %	1.0	1.0	1.0	1.0	1.0	1.0
Baking Powder%	1.0	1.0	1.0	1.0	1.0	1.0
Salt%	0.2	0.2	0.2	0.2	0.2	0.2
Pure Villain%	0.3	0.3	0.3	0.3	0.3	0.3
Cake gel improver %	0.5	0.5	0.5	0.5	0.5	0.5
*water (ml)	As required					

*water is added in ml=as required whey = whey protein concentrate powder.

Water activity

Water activity (a_w) was measured with arotronic. Hygro Lab EA10-SCS (Switzerland) a_w meter. The measurements were performed in triplicate out three times (Czuchajowska *et al.*, 1989).

Texture profile analysis (TPA) of cupcakes

Cupcakes Hardness, Cohesiveness, Chewiness, and Gumminess were assessed using the following criteria (Baixauli *et al.*, 2008). A universal testing device identified the specifications for cupcake texture (Brook field Engineering Lab. Inc., Middleboro, MA 02346-1031, USA). In a TPA, a cylindrical probe with a 25 mm diameter was employed at a speed of 2 mm/s.

Sensory evaluation of cupcakes

After baking, cupcake samples were allowed to cool for 4 hours at 25°C before being tested for organoleptic qualities. On white, odorless, and disposable plates, 10 skilled panelists—five men and five women—from the employees of the Food Technology Research Institute were given a slice of each cupcake sample. Samples were graded on their Crust Color (10), Crumb Color (10), texture (20), appearance (20), taste (20), moistness (10), flavor (10) and overall acceptability total score). The assessment was completed in accordance with Bennion & Bamford (1997).

Percentages of the recommended dietary allowances (% RDA) provided from Cupcakes

The percentages of the recommended dietary allowances (% RDA), as determined by the National Academies, the Institute of (Food and Nutrition Board, Institute of Medicine 2004).

Statistical analysis

SPSS 20.0 was used to examine the analytical data. Descriptive statistics were used to compute means and standard deviations. Analysis of one-way variance (ANOVA) and multiple range tests were used to compare samples. The cutoff for statistical significance was ($p < 0.05$) (Steel & Torrie, 1986).

Results and Discussion*Proximate analysis of the raw material*

Results in Table 2 present the proximate analysis of raw materials which used in cupcakes blends. Data show that the highest protein content was for whey protein concentrate powder (77%) followed by defatted almond flour (36%) then skim milk powder (33%)

compared to other ingredients. These findings surpass those of (GU *et al.*, 2019) who indicated that the protein concentration of whey protein concentrates ranges from 65 to 75%. As for different flours, defatted almond flour had the highest protein content (36%), fat 6.60 ash 5.90% and fiber 1.31%, which are in range of work by (Olatidoye *et al.*, 2011) they gave the Proximate analysis of defatted almond values of 3.3% fat; 4.8% ash and 0.4% fiber.

Results of Table 2 also indicated that the chickpea flour was 26.50% protein and 6.90% fat, while crude fiber, ash and carbohydrates were 1.45%; 3.26% and 61.89 %, respectively. These results are in range of work by Sakr & Hussien., (2017); Ammare *et al.* (2022). Chickpea and almond flours are abundant in vital proteins, fats, and many other micronutrients, including calcium, iron, zinc, and a number of vitamins, according to the USDA's Nutrient Database (USDOA, 2020a and b; Galal *et al.*, 2022).

Fresh egg on wet weight was (12.15%) Protein, (10.65%) Fat and (1.05%) Ash, these results are agreement with (Mostafa *et al.*, 2019) they found the proximate analysis of fresh egg near from this results. About minerals content, The highest values of calcium were found in Skimmed Milk Powder 1122.54 mg/100g followed by whey protein concentrate 397.61 mg/100g then defatted almond flour, chickpea flour and fresh egg (186.00, 56.20 and 47.9 mg/100g) respectively.

However chickpea flour and defatted almond flour were higher contain in iron and zinc (6.58 and 2.88) and (7.42 and 4.80) mg/100g respectively, then skimmed milk powder, while the lowest iron and zinc contain were found in fresh egg, wheat flour and whey protein concentrate, these results are agree with (Esmat *et al.*, 2010; U.S. Reference Manual, 2005). From results in Table 2, the wheat flour (72%) was the lower one in all nutrients except of carbohydrates.

Proximate analysis of Produced cupcakes samples

Table 3 explains the proximate analysis of multiple cupcakes formulas made from wheat flour 72% mixed with chickpea flour or wheat flour 72% mixed with chickpea flour and defatted almond flour all of those fortified by whey protein concentrate compared to control made from wheat flour 72% fortified by skimmed milk powder .

TABLE 2. Proximate analysis of the raw material (on dry basis).

(%)	Wheat Flour (72%)	Chickpea Flour	Defatted Almond Flour	Whey Protein Concentrate	Skimmed Milk Powder	Fresh egg*
Moisture	14.10±0.04	7.60±0.07	6.70±0.05	4.95±0.05	5.00±0.03	74.6±0.14
Protein	10.50±0.03	26.50±0.05	36.00±0.02	77.00±0.07	33.00±0.04	12.15±0.11
Fat	0.80±0.07	6.90±0.02	6.60±0.04	0.10±0.01	0.30±0.06	10.20±0.09
Ash	0.44±0.05	3.26±0.03	5.90±0.07	6.30±0.06	8.00±0.03	1.05±0.07
Crud Fiber	0.52±0.02	1.45±0.04	1.31±0.05	-	-	-
Carbohydrates	87.96±0.06	61.89±0.02	50.19±0.04	16.60±0.05	58.70±0.07	2.00±0.10
Minerals mg/100g						
Calcium	4.32±0.04	56.20±0.07	186.00±0.02	397.61±0.03	1122.54±0.05	47.9±0.06
Iron	0.41±0.06	6.58±0.03	7.42±0.04	0.21 ±0.06	0.70±0.03	0.12±0.03
Zinc	0.91±0.03	2.88±0.06	4.80±0.03	0.19±0.04	4.50±0.07	1.1±0.01

*Fresh egg on wet weight(Mean+ S.D).

TABLE 3. Proximate analysis of produced cupcakes samples.

	Control	F1	F2	F3	F4	F5
Moisture (%)	21.38 ^c ±0.02	21.90 ^d ±0.04	22.12 ^e ±0.09	22.61 ^b ±0.05	23.11 ^a ±0.03	23.14 ^a ±0.08
* Protein (%)	7.90 ^f ±0.09	9.50 ^e ±0.04	11.25 ^d ±0.07	12.50 ^c ±0.02	13.75 ^b ±0.05	15.00 ^a ±0.09
* Fat (%)	12.75 ^e ±0.05	12.75 ^e ±0.07	12.85 ^d ±0.09	13.13 ^c ±0.04	13.36 ^b ±0.08	13.65 ^a ±0.06
* Ash (%)	0.95 ^e ±0.03	0.92 ^e ±0.05	1.06 ^d ±0.04	1.42 ^c ±0.07	1.62 ^b ±0.09	1.74 ^a ±0.03
* Crud Fiber (%)	0.21 ^d ±0.06	0.21 ^d ±0.03	0.25 ^d ±0.02	1.17 ^c ±0.05	2.05 ^b ±0.03	2.94 ^a ±0.07
Carbohydrates (%)	78.19 ^a ±0.04	76.6 ^b ±0.06	74.59 ^c ±0.05	71.78 ^d ±0.03	69.22 ^e ±0.05	66.67 ^f ±0.04
Energy (K. cal)	459.11 ^a ±0.02	459.19 ^a ±0.07	459.00 ^b ±0.03	455.29 ^c ±0.05	455.63 ^d ±0.08	449.53 ^e ±0.05
Mineral (mg/100g)						
Calcium	80.13 ^a ±0.07	62.96 ^b ±0.04	68.75 ^c ±0.05	71.56 ^d ±0.08	73.56 ^e ±0.09	76.36 ^f ±0.03
Iron	0.72 ^c ±0.05	0.65 ^c ±0.07	1.20 ^b ±0.03	1.43 ^b ±0.06	1.61 ^b ±0.02	1.83 ^a ±0.05
Zinc	0.75 ^d ±0.05	0.6 ^c ±0.05	0.95 ^d ±0.06	1.20 ^c ±0.03	1.42 ^b ±0.05	1.65 ^a ±0.07

*On dry weight base. Data are expressed as mean ± standard deviation of three replicates. Numbers followed by different superscript lowercase letters within the same row are significantly different (*P* < 0.05) according to Duncan’s multiple range tests. Total carbohydrates were calculated by difference.

Cupcakes samples were significant increase in moisture, protein, fat, ash and crud fiber content. The moisture content of produced cupcakes increased significantly with the replacement of chickpea and defatted almond flour. Moisture content was highest in F5 (23.14%) and it was ranges (21.90-23.14%) in cupcakes samples while control sample was the lowest moisture content (21.38%), This increase might be attributed to the presence of high fiber content in both defatted almond and chickpea flour which has the property of enhancing the water absorption capacity of the

mixture. Stoin et al. (2018) explained this increase by the presence of hydroxyl groups in the almond fiber structure which allow more water interaction through hydrogen bonding and therefore high water absorption.

Replacement of skimmed milk by whey protein concentrate in F1 resulted in an increase in protein content from 7.90% in control to 9.50% this is attributed to the high protein content of whey powder, as shown in Table 2. Further replacement of wheat flour by chickpea flour results in a further

increase in protein (11.25%) in F2 this may be due to high protein contain in chickpea flour . These results agree with (Stoin *et al.*, 2018), while replacement of wheat flour by chickpea flour and defatted almond flour by different levels resulted a further increase in protein to reach in F3, F4 and F5 (12.50, 13.75and 15.00%) respectively. These results agree with Rizk *et al.* (2015), who reported that fortified cake with 10% chickpea flour led to increase the protein to 14.32%.

As for fat content, the maximum fat% was found in cupcakes F2 to F5 ranges were (12.85-13.65%) and minimum were reported in control and F1 value was (12.75%). This increase resulted from the high fat content of both defatted almond and chickpea flour. These results agree with (Jabeen *et al.*, 2022), they reported an increase in fat as a result of substitution of gluten free flour by a combination of almond, chickpea and flax seed flours. Also, ash content was high in cupcakes samples F2 to F5 ranges were (1.06-1.74%) the maximum was found in F5 (1.74%) and minimum amount of ash was in F1 and control (0.92-0.95%), respectively.

Crud fiber % was increased in cupcakes by replacement of wheat flour by chickpea and defatted almond flour ranges were (0.25-2.94), Maximum crud fiber%was found in F5 (2.94%) and minimum amount of fiber was in control and F1 (0.21%).The increase in these parameters could be due to the high content of protein,fat, ash and fiber in substitute flours compared with wheat flour (data presented in Table 2). These results agree with Rizk *et al.* (2015); Jabeen *et al.*, (2022). On the other hand, the results in same table showed that , the total carbohydrate content of cupcakes samples were significant decrease with control ,control was the highest in total carbohydrate content (78.19%) flowed by F1, F2, F3 and F4 (76.61,74.59,71.78 and 69.22%) respectively, while , F5 was been the lowest among the carbohydrate content(66.67%). Also,the Energy in samples were decreased and had significantly different with control sample values were decreased from 459.19 to449.53 (K. cal) in F1 to F5 compared with 459.11(K. cal) in control this due to effected by decreasing in carbohydrates % in cupcakes blends and increase in ash and crud fiber.

The minerals were increased by replacement of wheat flour by chickpea flour, defatted almond flour and whey protein concentrate powder in all produced cupcakes. Calcium was found low

in cupcakes samples F1 to F5 (62.96 to 76.36 mg/100g) while it was high in control (80.13 mg/100 g), this may be due to skim milk powder in control compared with whey protein concentrate powder and other ingredients incupcakes samples according to results which reported in Table 2 . However, Iron and zinc were increased incupcakes samples F2 to F5 by replacement of wheat flour be chickpea flour and defatted almond flour , Iron and zinc concentrate were high content in F5 sample (1.83 and 1.65 mg/100g) flowed by other cupcakes samples F2,F3 and F4 ranges were(1.20,1.43 and 1.61mg/100g),and (0.95 ,1.20, and 1.42mg/100g) then control (0.72 and 0.75 mg/100g) respectively ,while F1 was the lower sample in iron and zinc (0.65 and 0.63 mg/100g respectively). The increase in iron and zinc result properly from the replacement of wheat flour by defatted almond and chickpea flours, which are rich in their content. The results follow the same trend in previous studies by De Aguiar *et al.* (2015); Sakr & Hussien (2017) and Jabeen *et al.* (2022). From results in Table 3, the control sample was the lower one in all nutrients expiation of carbohydrates and calcium. As well as, the replacement of wheat flour by defatted almond and chickpea flours and fortified by whey protein concentrate led to improvement in chemical composition.

Amino acids (g/100g protein) of produced cupcakes samples

Data in Table 4 included that the amino acid composition, chemical score, and biological value of produced cupcakes samples were determined in comparison with the control. The obtained results revealed that F4 showed higher amounts of essential and non-essential amino acids followed by other samples (F1-F4) compared with control. The total essential amino acids were found in the amount of 49.2g/100g protein for F5 which was about 34.4, 40.1, 44.0and 46.6g/100g protein in F1, F2, F3 and F4 respectively and33.7g/100g protein for control. Chemical scores reflect the amount requirements of the essential amino acids as reported by (FAO/WHO 2007),which ranged from 37.93% to 133.3%, 39.65 % to 164.0%, 63.79 to 188.0%, 75.86 to 204.0 %, 84.48 to212.0% and 94.82% to 220% for the control, F1, F2, F3, F4 and F5, respectively. Also, total nonessential amino acids were increased with replacement in cupcakes samples compared with control. The increases in essential and nonessential amino acids values for cupcakes samples may be reflect the protein content and quality of chickpea

flour, defatted almond flour and whey protein concentrate, this results are agree with Galal et al. (2022), who found that the fortified of rice flaks by 40% chickpea flour led to improving in essential amino acids, chemical score and Biological value% in amino acids fractionation. Also, Hassan (2022) reported that the almond flour was the high contain in essential amino acids and good source for it.

The maximum of the biological value was reached to (88.44%) for F5 followed by (72.77%, 78.66% and 83.11%) for F2, F3 and F4, respectively while the lowest values were (59.10% and 60.0%) for control and F1, respectively. This means that the replacement of wheat flour by chickpea flour defatted almond flour and whey protein concentrate in cupcakes samples led to improving in protein quality, easily digested and utilized.

Physical properties of produced cupcakes samples

Table 5 describes the physical properties of both the generated in control and cupcakes

samples for weight (g), height (cm), volume (cm³), specific volume (cm³/g) and water activity (a_w), control and (F1) were did not significantly differences for weight and height, while samples F2 to F5 were significantly higher in weight ranges were (30.43-31.70g) then (29.76 and 29.80g) in control and F1, respectively, This increase may be a result of high protein contain and crude fiber content in chickpea flour and defatted almond flour which increase the water-holding capacity. There was no significant difference in height between control and F1, but the height of F2-F5 was significantly decrease, values were (5.24 and 5.19 cm) in control and F1 respectively, to ranges (4.90-4.08 cm) in F2 to F5, this decrease may be due to the effects of increasing the addition of defatted almond flour, chickpea flour and whey protein concentration which led to fewer air cells and the baked goods' weak ability to retain air bubbles, as anticipated was attributed, by Gadallah (2017); Jabeen et al. (2022).

TABLE 4. Amino acid composition(g/100g protein) of produced cupcakes samples.

	C	CS%	F1	CS%	F2	CS%	F3	CS%	F4	CS%	F5	CS%	FAO/ WHO (2007)
Essential amino acids													
Threonine	3.2	94.11	3.3	97.05	4.0	117.64	4.4	129.41	4.7	138.23	5.1	150	3.4
Valine	4.4	110.0	4.5	112.5	5.0	125.0	5.5	137.5	5.9	147.50	6.3	157.5	4.0
Isoleucine	4.0	133.3	4.1	136.66	4.5	150.0	5.1	170.0	5.3	176.66	5.6	186.66	3.0
Leucine	7.6	115.15	7.7	116.66	8.3	125.75	8.7	131.81	9.0	136.36	9.2	139.39	6.6
Phenylalanine	5.3	84.12	5.4	85.71	6.1	96.82	6.6	104.76	7.0	111.11	7.3	115.87	6.3
Lysine	2.2	37.93	2.3	39.65	3.7	63.79	4.4	75.86	4.9	84.48	5.5	94.82	5.8
Tyrosine	3.0	78.94	3.0	78.94	3.8	100.0	4.2	110.5	4.5	118.42	4.7	123.68	3.8
Methionine + Cystine	4.0	160.0	4.1	164.0	4.7	188.0	5.1	204.0	5.3	212.0	5.5	220.0	2.5
Total EAA (%)	33.7		34.4		40.1		44.0		46.6		49.2		
Non-essential amino acids													
Aspartic acid	4.0		4.2		4.9		5.3		5.6		5.9		
Serine	4.0		4.1		4.3		4.6		5.0		5.5		
Glutamic	14.4		14.7		17.0		17.4		17.7		18.2		
Glycine	3.3		3.4		4.4		4.8		5.0		5.4		
Alanine	3.1		3.1		2.7		3.2		3.7		4.3		
Histidine	2.2		2.4		2.9		3.1		3.4		3.8		
Arginine	3.9		4.0		4.8		5.3		5.6		6.0		
Proline	7.2		7.3		6.1		6.5		7.1		7.7		
Total NEAA (%)	42.10		43.2		47.1		50.2		53.4		56.8		
Biological value%	59.10		60.0		72.77		78.66		83.11		88.44		

C= Control ,CS= Chemical score%, B.V= biological value of protein, EAA= Essential amino acids, NEAA=Non-essential amino acid.

TABLE 5. Physical Properties of produced cupcakes samples.

Formula	Weight (g)	Height (cm)	Volume (cm ³)	Specific Volume(cm ³ /g)	Water Activity(a _w)
Control	29.76 ^c ±0.07	5.24 ^a ±0.02	74.88 ^a ±0.05	2.52 ^a ±0.03	0.722 ^c ±0.07
F1	29.80 ^c ±0.03	5.19 ^a ±0.05	74.80 ^a ±0.03	2.51 ^a ±0.02	0.723 ^{de} ±0.02
F2	30.43 ^d ±0.06	4.90 ^b ±0.03	73.57 ^b ±0.06	2.42 ^b ±0.04	0.724 ^{cd} ±0.05
F3	30.90 ^c ±0.03	4.59 ^c ±0.07	72.65 ^c ±0.04	2.35 ^c ±0.07	0.726 ^c ±0.03
F4	31.32 ^b ±0.05	4.34 ^d ±0.05	71.08 ^d ±0.02	2.27 ^d ±0.06	0.727 ^b ±0.04
F5	31.70 ^a ±0.02	4.08 ^c ±0.04	70.13 ^e ±0.02	2.21 ^e ±0.08	0.729 ^a ±0.05

* Data are expressed as mean ± standard deviation of three replicates. Numbers followed by different superscript lowercase letters within the same a column are significantly different ($P < 0.05$) according to Duncan's multiple range

Also, there was no significant difference in volume observed between control and (F1)while F2,F3,F4 and F5 were significant difference with control, the highest volume was observed in control and F1 (74.88 and 74.80cm³) respectively, while the volume was decreased in F2to F5 ranges were (73.57-70.13cm³) this may be due to fiber and moisture content this results are agreement with Kilcast(2013) who's reported, that sugar, fats and moisture content were had good effects on cake volume ,also the flour granule size, fiber content and water absorption capacity, all of them have an impact on the ultimate volume of cupcakes. While Andersson (2016) reported a positive relation between starch content of flour and volume but with no linear relationship, indicating the presence of additional factors that affect the ultimate volume.

The specific volume and density follow the same trend. The batter's air inclusion was reduced due to the presence of chickpea flour, resulting in higher density cupcakes. Herranz et al. (2016) reported samples higher protein and fiber content of chickpea flour resulting in less water being available for the starch-protein network to grow during baking, resulting in a reduction in muffin volume. (Martinez-Cervera et al., 2011) reported that the final volume in baking is influenced by a number of interconnected variables, including the rheological characteristics of the batter (affected by ingredients), the amount of air incorporated, and the time and speed of mixing and homogenization.

As for Water Activity (a_w), Fontana (2000) reported that the state of water activity is important for predicting the microbiological growth, degradation processes, and chemical and physical aspects of food stability and safety. Water Activity(a_w) in cupcakes samples was significant increaseanddifferenceswhen compared with control , thewater activity(a_w) ranges were (0.723-0.729) in cupcakes samples F1 to F5 and (0.722) in control,this increase may be due to higher protein and crud fiber content in cupcakes samples which increase the water absorption . These results agree with work by(Herranz et al. (2016),who reported 15%whey protein muffins to have significantly higher water activity than control, they referred the increase because of the larger protein content in this sample, to be related to greater water absorption.

Texture profile Analysisof produced cupcakes samples

When analyzing cupcakes products, the texture profile analysis (TPA) is very important and highly helpful technique. In this case, the key textural characteristic of cupcakes that is associated to quality is hardness (Vassiliki & Vassiliki, 2013).

In the present study, the TPA parameters of cupcakes samples and control from wheat flour 72% with skim milk powder , were measured by the texture analyzer (Hardness(N), Cohesiveness, Chewiness(N) and Gumminess(N)) shown in Table 6.

TABLE 6. Texture profile analysis of produced cupcakes samples.

Formulas	Hardness (N)	Cohesiveness	Chewiness(N)	Gumminess(N)
Control	3.43 ^f ±0.04	0.72 ^a ±0.02	2.32 ^c ±0.04	2.92 ^c ±0.03
F1	4.03 ^e ±0.02	0.70 ^a ±0.04	3.24 ^c ±0.01	3.00 ^c ±0.05
F2	4.62 ^d ±0.06	0.65 ^a ±0.01	4.12 ^b ±0.02	4.14 ^b ±0.01
F3	5.15 ^c ±0.05	0.60 ^a ±0.03	4.93 ^b ±0.05	4.85 ^b ±0.01
F4	5.55 ^b ±0.02	0.56 ^b ±0.05	5.35 ^a ±0.03	5.52 ^a ±0.03
F5	5.83 ^a ±0.03	0.53 ^b ±0.02	5.72 ^a ±0.02	6.22 ^a ±0.03

* Data are expressed as mean ± standard deviation of three replicates. Numbers followed by different superscript lowercase letters within the same a column are significantly different ($P < 0.05$) according to Duncan's multiple range test.

Hardness is defined as the cupcakes products initial compression's maximum force at 50% compression (1mm/s speed test). The hardness of cupcakes samples showed a dramatic significant difference in statically analysis, hardness was 3.43 N for control, and it increased with the addition of varying amounts of chickpea, defatted almond and whey protein concentrate powder from 4.03, 4.62 and 5.15 N in F1, F2, and F3, respectively, and more reaches to 5.83 N for F5, the increase of Hardness may be related to the present of crud fiberin cupcakes samples. Martinez-Cervera et al. (2013) reported that the of protein and gluten quality of flours influence provides harder texture and higher water absorption on the initial hardness was inversely proportional to the muffins volume. Therefore, the initial firmness increased when the percentage of chickpea flour increased. These results agree with work by Gomez et al. (2008).

Cohesiveness is determined from the strength of the internal bonds in the food structure and is affected by moisture content. Cohesiveness was also dependent on moisture content, the greater the moisture content the greater the cake samples of cohesiveness (Al-Muhtaseb et al., 2013). The results in same table showed that cohesiveness for control was (0.72) which decreased in F1 to (0.70). followed by F2 (0.65), reaching (0.53) for F5, this decrease in cohesiveness of cupcakes samples may be due to the increased fiber content that interferes with development of gluten network and led to weak adhesion between the fibers and gluten starch matrix. These results are in accordance with the study by (Jabeen et al., 2022) they reported there is decrease in cohesiveness with almond and chickpea replacement in cake. Also, Gomez et al. (2008) reported cohesiveness

to decrease when the percentage of chickpea flour increased. Also, Premi & Sharma (2018) reported that.

Gumminess (N) for control was (2.92 N) which increased in F1 to (3.00N), followed by F2 (4.14N), then F3 (4.85N), F4 (5.52N) and reaching (6.22 N) for F5, (Rosenthal, 1999) defined gumminess as the force required to disintegrate a semi - solid food before it is ready for swallowing. While Lu et al. (2010), defined chewiness as the amount of energy required to disintegrate a food, and is a parameter dependent on firmness. So as expected gumminess and chewiness followed the similar trend of hardness and increased with increase in replacement level (Premi and Sharma, 2018). The observations of this study correlate with those seen in other studies. In (Gomez et al., 2008), study as the percentage of chickpea flour increased, gumminess and chewiness increased. (Jia et al., 2008), replaced varying levels of wheat flour with almond flour in Chinese moon cakes and reported that almond flour increased the chewiness. Majzoobi et al. (2014) stated that different factors may be effect of cake texture including cake composition, water content and cake volume. Nevertheless, the interaction of all these parameters is a determining factor affecting on the textural properties of the final product.

Percentages of the Recommended Dietary Allowances Provided from produced Cupcakes for Children (4-8 and 9-13 years)

The percentages of the recommended dietary allowances (RDA%), as determined by the National Academies, the Institute of Medicine, and the Food and Nutrition Board 2004, provided from 100g of cupcakes for both children 4-8

years and children 9-13 years are shown in Table 7, It could be observed that supplementation of cupcakes with whey protein concentrate, defatted almond flour was covers high present from essential nutrients for children 4-8 years and children 9-13 years. But the supplementation of cupcakes with whey protein concentrate, defatted almond and chickpea flour (F5) covers up to 78.94 % of protein requirement, 18.30% of iron requirement and 33.3% of zinc for children 4-8 years compared with control 41.57%,7.20% and 15.00 % in Protein, Iron and Zinc, respectively. Whereas, its cupcakes sample F5 cover up to 44.11% of protein requirement, 22.87% of iron requirement and 20.62% of zinc for children 9-12 years are shown in the same table compared with control 23.23, 9.00 and 9.37% in Protein, Iron and Zinc respectively, this may be due to high nutritional value in raw material which used. According to estimated average requirements (EAR), the nutritional profile of F5 was the highest of all samples and can be categorized as high nutrient for both children 4-8 years and 9-13 years. The addition of whey protein defatted almond flour and chickpea flour resulted in an increase in protein, iron and zinc, which presents almost twice the percent covered by control for both categories. Micronutrient improvement, although might be considered (mild), with the addition of almond and chickpea flours, can help to correct various nutritional deficiencies (Krupa-Kozak & Lange, 2019). The results in same table showed that the recommended good percentage from calcium were similar between F5 and control for both children 4-8 years and 9-13 year's needs, while the other formulas were low in % recommended daily allowances from calcium. From results in Table 7, the control sample was

the lower one in all nutritional values. while, the replacement of wheat flour 72% by chickpea flour fortified by whey protein concentrate in F2 led to some improvement in recommended daily of dietary allowances ratio and more improvement in nutritional values was found with the replacement of wheat flour 72% by chickpea flour and defatted almond flour fortified by whey protein concentrate in F3 and F4, while the best improvement in recommended daily of dietary allowances was found in F5 which made from wheat flour 72% mix with chickpea flour and defatted almond flour fortified by whey protein concentrate compared with low levels in control made from wheat flour 72% and skimmed milk powder.

Sensory evaluation of produced cupcakes samples

Sensory evaluation (crust color, crumb color, texture, appearance, taste, moistness, flavor and Overall acceptability) were evaluated and recorded in Table 8. C, F1 and F2 cupcakes samples were recorded the highest scores among all sensory evaluation parameters, crust color, crumb color, taste, appearance, texture, taste, moistness and flavor, also, F1, F2 and F3 showed no significant difference compared with control, while all other cupcakes samples (F4 and F5) had low scores, but good acceptable values in texture, appearance, moistness and flavor, the scores of (F4 and F5) were recorded significant differences compared to control in statistical analysis. While the taste and flavor showed no significant differences between all cupcakes samples and control. As for overall acceptability (Total score) found that, the F1, F2 and F3 samples were no significant differences compared to control, while all other treatments had lower scores, but good and acceptable scores, results are agree with results which found by Jabeen et al. (2022).

TABLE 7. Percentages of the recommended dietary allowances provided from produced Cupcakes for Children (4-8 and 9-13 years).

Formulas	4-8 Years(%)				9-13 Years (%)			
	Protein (19 g/d)	Calcium (1000 mg/d)	Iron (10 mg/d)	Zinc (5 mg/d)	Protein (34gm/d)	Calcium (1300mg/d)	Iron (8mg/d)	Zinc (8mg/d)
Control	41.57	8.13	7.20	15.00	23.23	6.16	9.00	9.37
F1	50.00	6.29	6.50	12.60	27.94	4.84	8.12	7.87
F2	59.21	6.87	12.00	19.00	33.08	5.28	15.00	11.87
F3	65.87	7.15	14.30	24.00	36.76	55.04	17.87	15.00
F4	72.36	7.35	16.10	28.40	40.44	5.65	20.12	17.75
F5	78.94	7.63	18.30	33.30	44.11	5.87	22.87	20.62

Food and Nutrition Board, Institute of Medicine, & National Academies, 2004

TABLE 8. Sensory evaluation of produced cupcakes samples.

Samples	Crust Color	Crumb Color	Texture	Appearance	Taste	Moistness	Flavor	Overall acceptability (Total score)
Control	9.76 ^a ±0.02	9.58 ^a ±0.07	19.75 ^a ±0.03	19.83 ^a ±0.06	19.48 ^a ±0.05	9.65 ^a ±0.04	9.85 ^a ±0.02	97.85 ±0.04 ^a
F1	9.75 ^a ±0.06	9.57 ^a ±0.05	19.72 ^a ±0.09	19.81 ^a ±0.03	19.47 ^a ±0.04	9.63 ^a ±0.06	9.82 ^a ±0.07	97.77 ^a ±0.02
F2	9.48 ^a ±0.03	9.50 ^a ±0.23	19.68 ^a ±0.06	19.70 ^a ±0.04	19.44 ^a ±0.09	9.58 ^a ±0.07	9.77 ^a ±0.05	97.17 ^a ±0.03
F3	9.32 ^a ±0.07	9.50 ^a ±0.04	19.48 ^a ±0.05	19.63 ^a ±0.09	19.42 ^a ±0.02	9.53 ^a ±0.09	9.72 ^a ±0.04	96.59 ^a ±0.06
F4	9.23 ^b ±0.05	9.48 ^a ±0.03	19.42 ^b ±0.09	19.57 ^b ±0.02	19.37 ^a ±0.06	9.43 ^b ±0.02	9.64 ^a ±0.09	96.15 ^b ±0.07
F5	9.12 c±0.04	9.46 ^a ±0.06	19.03 ^c ±0.02	19.48 ^b ±0.07	19.34 ^a ±0.03	9.37 ^b ±0.05	9.62 ^a ±0.06	95.42 ^b ±0.09

*The mean and standard deviation of ten replicates are used to express the data. The Duncan's multiple range test shows that within a column, numbers followed by various superscript lowercase letters are significantly different ($P < 0.05$) according to Duncan's multiple range test.

Conclusion

These results show that replacement WF (72%) by (CF) alone or (CF) and (DAF) different levels, all of them fortified by WPCP compared with (C) from WF with (SMP) led to improving in the nutritional value (protein, dietary fiber and essential minerals) and increasing in essential amino acids and biological value of protein of produced cupcakes. Also, achieving a high percentage of Recommended Dietary Allowances of essential nutrients are for children of these ages 4-8 Years and 9-13 Years. This work may be able to help of reducing malnutrition problems for Primary Stage Children, but the best nutritional improving was found in F5, while F3 was the best balance between the nutritional value and technological quality. Also, this work may help to maximize the utilization of almond cake by-product after almond oil extraction.

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إنتاج كعك كيك مرتفع في القيمة الغذائية لأطفال المرحلة الابتدائية.

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أجريت هذه الدراسة لتطوير إنتاج الكعك كيك بوصفة مبتكرة ذات قيمة غذائية عن طريق استبدال دقيق القمح بدقيق الحمص او دقيق الحمص ودقيق اللوز منزوع الدسم منتج ثانوي ودعمت هذه الخلطات بمسحوق بروتين الشرش المركز مع استخدام كينترول من دقيق القمح ٧٢٪ مدعم بمسحوق اللبن منزوع الدسم . بدراسة التركيب الكيميائي للخمات وجد ان بروتين مسحوق شرش اللبن المركز أعلى في البروتين (٧٧٪) يليه ودقيق اللوز منزوع الدسم (٣٦٪) ثم مسحوق اللبن منزوع الدسم (٣٣٪) ثم دقيق الحمص (٢٦,٥٪). ايضاً كان دقيق الحمص ودقيق اللوز منزوع الدسم الاعلى في محتوى الدهون والالياف الخام مقارنة بالمكونات الأخرى وكان الحليب مسحوق منزوع الدسم ومسحوق شرش اللبن المركز الاعلى في نسبة الرماد يليهم او دقيق الحمص ودقيق اللوز منزوع الدسم. أدى استبدال الحليب منزوع الدسم بمركز بروتين شرش اللبن في عينة الكعك كيك (١) إلى زيادة محتوى البروتين ٧,٩٪ في الكينترول إلى ٩,٥٪, كما أدى استبدال دقيق القمح بدقيق الحمص في عينة (٢) إلى زيادة أخرى في البروتين (١١,٢٥٪). بينما أدى استبدال دقيق القمح بدقيق الحمص ودقيق اللوز ومسحوق بروتين الشرش في عينات (٥,٤,٣) إلى ارتفاع البروتين ١٢,٥ الى ١٥٪. أدى الاستبدال الى مضاعفة كلا من الالياف والحديد والزنك في عينات الكعك كيك ومستوي جيد من الكالسيوم مقارنة بالكينترول. تم تقدير للاحماض الامينية لعينات الكعك كيك وجد ان الاستبدال أدى الى ارتفاع العنات الكعك كيك مقارنة بالكينترول في الاحماض الامينية الاساسية والتركيب الكيميائي والقيمة البيولوجية للبروتين. بالنسبة للخواص الفيزيائية لعينات الكعك كيك (الارتفاع) لم يكن هناك فرق معنوي كبير في الارتفاع بين عينات الكعك كيك (٣,٢,١) مع الكينترول بينما انخفض بشكل معنوي من ٥,٢٤ سم في الكينترول إلى ٤,٠٨ سم في العينة (٥) مع زيادة نسبة الاستبدال بالحمص ودقيق اللوز مقارنة بالكينترول، ايضاً كان الحجم والحجم النوعي لعينات الكعك كيك في نفس الاتجاه بينما أدى الاستبدال الى ارتفاع طفيف في النشاط المائي . أدى الاستبدال الى انخفاض طفيف في خواص القوام ولكنها جيدة. بالنسبة للتقييم الحسي حصل الكينترول والعينات (٢,١) على أعلى الدرجات جميعاً لخواص الحسيه، لم تظهر أي فروق معنوية مقارنة بالكينترول، العينات (٥,٤,٣) أقل بنسبه طفيفه ولكنها جيدة ومقبولة. أدى الاستبدال الى تحسن ملحوظ في القيمة الغذائية لعينات الكعك كيك من خلال مضاعفة كلا من المحتوى البروتيني والمعادن الاساسية والالياف الغذائية ويمكن ان يحقق نسبة مرتفعة من الاحتياجات اليومية للأطفال في سن مبكرة من خلال منتج محبب لديهم.