Evaluation of certain Egyptian *Al-Dokka* mixes in some Egyptian governorates

Abstract

Al-dokka is a distinctive Egyptian meal commonly eaten with bread and olive oil. Its ingredients vary depending on the region or the family/vendor making it. Despite its low cost and long shelf life, it is at risk of extinction due to the trend towards fast and easy-to-prepare foods despite their low nutritional and health value. The study aims to evaluate the nutritional and health benefits of Egyptian *al-dokka* mixtures, produced in various Egyptian governorates, to revive the use of these ancient popular foods. The study collected *al-dokka* samples from 10 Egyptian governorates for sensory evaluation and analysis. The components included sesame, peanuts, chickpeas, pumpkin seeds, zucchini seeds, apricot kernels, date pits, coriander, cumin, and salt in different proportions according to each governorate. The results of the study indicate that the Egyptian *al-dokka*, an ancient popular dish, has a high nutritional value. A snack consisting of 100 grams of *al-dokka* with a loaf of *baladi* bread (black bread) and 20 grams of olive oil provides about one-third of the protein needs of an adult person weighing 70 kg, in addition to 72.2% of the fat needs. It also covers 17% to 20% of the carbohydrate needs, and provides about 34.6% and 44.1% of the total daily calories for adult men and women, respectively. Assiut and Sohag samples exhibited the highest phenol content and antioxidant activity, attributed to their high content of cumin and coriander. The Gharbia sample also, exhibited high antioxidant activity due to its high pumpkin seed content. The samples showed varying levels of saturated fatty acids (SFAs) and total unsaturated fatty acids (TUFAs), with SFAs ranging from 13.26% to 17.96% and TUFAs from 82.04% to 85.44%. High proportions of apricot kernels, date seeds, coriander, and cumin in Qena, Siwi, Assiut, and Sohag samples negatively impacted sensory characteristics and overall acceptance. Date seeds fibers increased mouth roughness, while high amounts of cumin and coriander reduced sensory measures. Apricot kernels cause lumps in the texture and are not recommended for consumption due to toxic substances like cyanogenic glycoside (amygdalin), which become more decomposes by kernals ground and releases cyanide. The mixtures from Alexandria, Sharkia, Ismailia, Port Said, Gharbia, and Cairo are recommended due to their health, nutritional benefits, and sensory properties.

Keywords: *Al-dokka*; ancient popular; foods; dish; sesame; peanuts; chickpeas; pumpkin seeds; zucchini seeds; apricot kernels; date pits; coriander; cumin; black bread

1. Introduction

Al-dokka, also known as *duqqa* or *dukkah* or *dukka*, is a flavorful spice blend originating from Egypt. It consists of a mix of salt, black pepper, ground cumin, sesame, and coriander. In Egypt, it is commonly eaten with bread and olive oil. Despite its Egyptian roots, it has gained widespread popularity in various other countries such as Saudi Arabia, Turkey, Iran, Palestine, especially Gaza, Australia and America [1]. Egyptian *al-dokka* is a mix of dried and ground coriander, cumin, caraway, salt, pepper, roasted sesame, and ground peanuts [2]. *Al-dokka* is a distinctive Egyptian meal made of roasted nuts and spices. It tastes great in salads or combined with mayonnaise for dipping. It can also be used as a flavorful coating for chicken before grilling or pan-frying. The word "*dukkah*" is derived from the Arabic word "daq," meaning grinding, as the mixture of spices and nuts is ground together after being roasted [3, 4]. According to [5], *al-dokka* is a mixture of sesame seeds, cumin seeds, roasted hazelnuts or chickpeas, coriander, sea salt, and black peppercorns. *Al-dokka* is commonly used as a spice in the Middle East and is often served at the table as a condiment to be sprinkled over meals. In Turkey and Iran, it is used like salt and pepper and is frequently placed on tables in bowls or shakers, especially at kebab restaurants. In the West, it is used as a spice for grilled meats and is added to onions and salt to enhance the flavor of meat dishes, curries, seafood, vegetables, rice, salads, stews, and sauces. It is also used as a seasoning for grilled and fried meats in various Arab countries, particularly in the eastern Mediterranean. It is mixed with olive oil in Egypt and served as a bread dip [6]. Al-dokka is a popular spice mixture in the Arab world, with its ingredients varying from country to country [7]. The most well-known variations are Egyptian al-dokka and Palestinian *al-dokka*, especially in Gaza City. *Al-dokka* is known for its inexpensive ingredients and long shelf life, making it suitable for those with limited income, but many affluent individuals also enjoy it. The exact composition of the spice mixture may vary from one family or vendor to another, although there are common ingredients such as sesame, coriander, cumin, salt, and black pepper [8]. The mixture can be enhanced with additional ingredients such as marjoram, mint, thyme, and chickpeas, as suggested by

[9]. They also recommend using ginger, millet flour, and dried cheese. In addition, modern variations may include pine nuts, pumpkin seeds, and sunflower seeds. *Al-dokka* is a significant part of Egyptian folklore cuisine, renowned for its high nutritional and health benefits. Sadly, this traditional dish is on the verge of disappearing due to the prevailing consumption patterns favoring fast-prepared and inexpensive options. This shift has led to the neglect of many old popular dishes celebrated for their nutritional and health value. In a study by [1], a modified *al-dokka* was developed by blending ground fermented wheat, sesame, coriander, cumin, chicory leaves, cinnamon, turmeric, and date seed powder. This *al-dokka* demonstrated hypoglycemic effects in diabetic rats and effectively lowered cholesterol, triglycerides, and LDL-Ch levels, while improving liver and kidney functions. Moreover, the diabetic rats that consumed the modified *al-dokka* showed higher insulin concentrations compared to the diabetic control rats. Furthermore, the formulated *al-dokka* was found to increase both serum and femur magnesium concentration. Hence, the formulated *al-dokka* could serve as a beneficial dietary supplement for managing diabetes. Insulin concentrations were observed to be higher in rats fed the formulated *al-dokka*, which may have contributed to the reduction in triglycerides and LDL cholesterol levels and thus reduced the resulting cardiovascular problems. Sesamin in sesame seeds promotes cholesterol excretion into bile and regulates the activity of 3-hydroxy-3-methylglutaryl coenzyme A reductase, a critical enzyme in cholesterol production [10]. Feeding on the formulated *al-dokka* reduced functional abnormalities caused by nephropathy, one of the most prevalent diabetic sequelae. This impact might be attributed to the hypolipidemic and antioxidant effects of phenolic compounds found in *al-dokka* components, notably sesame and coriander seeds and chicory leaves, as previously established [11, 12, 13, 14. Sesame seeds also contributed to *al-dokka's* hypoglycemic impact since they include anti-diabetic lignans including sesamin [15], phenolic compounds, and dietary fibers [16]. Sesame oil had an anti-diabetic impact, reduced oxidative stress, and safely synergized with hypoglycemic medicines [17].

Human nutrition is shifting towards plant-based products for their high nutritional value and affordability, aiming to combat the negative effects of low-nutritional fast foods [18, 19]. *Al-dokka* has a good amount of protein, fat, and carbs, as well as vitamins, dietary fiber, phenolic compounds, and flavonoids. It is an old popular cuisine that can help with a variety of nutritional issues because to its high protein and amino acid content (from sesame, peanuts, and chickpeas). Combining grains and legume proteins can create protein components that offer a balanced amino acid source, meeting physiological requirements and increasing protein nutritional value [20]. In addition to being high in fat, it is a low-cost alternative to red meat, reducing the negative impact of not eating meat and fat on the middle and lower classes owing to increasing food costs and population expansion. As protein consumption rises due to the health advantages and safety of animal proteins, there is a growing need for edible proteins derived from plants [18, 20]. Interest in these alternatives has lately developed due to a decrease in meat output due to agricultural land stability, high feed prices, and a severe irrigation water deficit. This is owing to an increase in issues caused by a growth in population and the number of refugees, as the number of refugees in Egypt has reached around 13 million people, as well as crises caused by supply shortages caused by continuous global wars with currency liquidity crises. To effectively utilize resources, it is important to offer a diverse range of food options that can meet the nutritional needs of consumers, especially those in the middle and lower socioeconomic classes, using easily accessible raw materials. The study aimed to assess the nutritional value of Egyptian *al-Dokka* mixes made with different combinations from various regions, aiming to revitalize traditional foods. These mixes, whether consumed alone or in combination with other foods, may address the deficiencies in macro- and micronutrients in the diet.

2. Materials and Methods

2.1. Materials

The raw materials used in the manufacture of *al-Dokka* include sesame (*Sesamum indicum*), chickpea (*Cicer arietinum* L.), peanut (*Arachis hypogaea* L.), pumpkin seed (*Cucurbita maxima* L.), apricot kernel (*Prunus armeniaca* L.), zucchini seed (*Cucurbita pepo*), coriander (*Coriandrum sativum*), cumin (*Cuminum cyminum*), date palm seed (*Phoenix dactylifera*), and table salt.

2. 2. Chemicals and reagents

Every reagent used was analytical grade.

2.3. Methods

2.3.1. Collection of al Dokka samples

Samples were collected from different governorates within the Arab Republic of Egypt. The samples included components such as sesame, peanuts, chickpeas, pumpkin seeds, zucchini seeds, apricot kernels, date pits, coriander, cumin, and salt. These samples were collected from 10 different governorates, namely Cairo, Ismailia, Sharkia, Qena, Gharbia, Siwa, Alexandria, Port Said, Assiut, and Sohag. The composition of the sample components was confirmed by collecting multiple samples from each governorate, including samples from residents and restaurants. The samples were stored in tightly sealed glass containers and transferred to the laboratory for analysis and sensory evaluation. **Table 1** displays the approximate composition of the components used in the collected *al-dokka* from different governorates

Table 1 Presents the proximate composition of various components used in the production of Al-Dokka sourced from different governorates.

Ingredients / Governorate	Sesame seeds	Peanut	Chickpea	Apricot kernels	Pumpkin seeds	Date seed	Zucchini seeds	coriander	cumin	salt
Cairo	1.0	1.0								*
Ismailia	1.0	1.0	1							*
Sharkia	2.0	1.0	1							*
Qena	4.5	2.5	2.5	1				*	*	*
Gharbia	4.5	2.5	2.5		1					*
Siwi	4.5	2.5	2.5			1		*	*	*
Alexandria	2.0	1.0					2			*
Port Said	2.0	1.0								*
Assiut	2.0	1.0						1	1	*
Sohag	2.0			1				1	1	*

***A simple sprinkle to adjust the taste.**

2.3.2. Preparation of al Dokka

Except for the fine salt, all of the components (sesame, peanuts, chickpeas, apricot kernels, date pits, coriander, cumin, pumpkin seeds, and zucchini seeds) are roasted, and the last two are peeled. Each ingredient is then ground separately until smooth, and the components are combined in the proportions specified for each recipe.

2.3.3. Proximate analysis of al Dokka

The [21] standard procedures were carried out to in order to estimate the proximate composition. The moisture content was determined in an air dryer oven at 105°C for 3 hours, and the weight after constant drying was recorded. Ash content was determined by igniting the sample in a muffle furnace at 600°C until it was carbon-free. Crude fat was extracted using diethyl ether in a Soxhlet apparatus. Crude fiber was determined as residue after acid digestion followed by alkali digestion. The nitrogen content was determined using the Kjeldahl method and was used to calculate the protein content. Total carbohydrates were estimated using the following equation: Available carbohydrates = 100 – (moisture +protein + fat + fiber + ash).

2.3.4. Extraction of phenolic compounds

The samples' phenolic components were extracted in accordance with [22]. Two extractions were performed using a methanol solution (80% v/v) as the solvent (mass volume ratio: 1:15). After the extracts were combined, filtered, and examined for phenolic acids and antioxidant activity.

2.3.5. Determination of total phenolic content

With minor modifications, the folin-Ciocalteu (FC) technique as described by [23] was utilized to determine the total phenol concentration. After diluting the extract to 3.8 mL with 250 µL of FC reagent, the mixture was allowed to react for eight minutes. After adding 20% sodium carbonate (900 µL) and letting it stand in the dark for an hour, the absorbance at 750 nm was measured using a spectrophotometer. The gallic acid standard curve was created using the same parameters. Gallic acid (mg) was used to represent total phenols per gram of *al-dokka* (mg GAE/g).

2.3.6. Determination of flavonoid content

The flavonoid content was measured using an aluminum chloride assay based on the method outlined in Ref. [24] with some adjustments. A 0.5 cm3 sample extract was mixed with 2 cm^3 of distilled water in a test tube. Then, 0.15 cm3 of 5% NaNO2 was added, followed by 0.15 cm^3 of 10% $AlCl_3$ after 5 minutes of incubation. After 1 minute, 1 cm^3 of NaOH (1 M) was added. The volume was adjusted to 5 cm^3 with distilled water, and after 10 minutes, the absorbance of the solution was measured at 510 nm. The total flavonoid content of the samples was expressed as mg catechin equivalent per 100 g of the dry mass (mg CE/100 g). Catechin was used as a standard. All samples were analyzed in triplicate.

2.3.7. Determination of antioxidant activity

With certain adjustments, the DPPH technique [25] was used to measure the antioxidant activity. In order to make the stock reagent, 22 mg of DPPH were dissolved in 50 mL of methanol. To create the working solution, add 94 mL of methanol to 6 mL of stock solution. 0.1 ml of sample extract and 3.9 ml of DPPH solution were combined, vortexed for 30 seconds, allowed to react for 30 minutes, and then the mixture was absorbed at 515 nm. The DPPH solution without any additional extract was the control . % Scavenging activity was calculated as follows= $[(Ac_{ontrol}-A_{sample})/A_{control}] \times 100$

where A is the absorbance at 515 nm.

2.3.8. Fatty Acids Composition

Preparation of fatty acids methyl esters

Fatty acid methyl esters (FAMES) are formed from total lipid by employing the fast technique described in [26]. FAMES were produced by trans-esterification using methanolic potassium hydroxide (MPH) as an intermediary step prior to saponification. Exactly 0.1 g oil was put in a 5-ml screw-top test tube, and 2 ml of isooctane has been added before shaking the tube. MPH solution (0.1 ml, 2 N) was placed on a cap with a PTFE joint, tightened, and forcefully shaken for 30 seconds. The tube was permitted to stratify till the top solution became clear, after which the methyl ester-containing upper layer was decanted.

Gas Liquid Chromatographic (GLC) of Methyl Esters of Fatty Acids

FAMES were injected on HP 6890 series GC equipped with a DB-23 column (60m x 0.32mm x 25 µm). Carrier gas is N2, using a flow rate of 1.5 ml/min and a splitting ratio (1:50). The injector set at 250°C, whereas the Flame Ionization Detector (FID) set at 280°C. The temperature was set as following.: 150°C to 210°C at 5°C/min, then stay at 210°C for 25 minutes. Peaks have been identified via comparing the retention periods of standard methyl esters.

2.3.9. Determination of Vitamin E, D and K by HPLC

A 10 g sample was combined with 0.5 g ascorbic acid, 40 ml methyl alcohol, and 10 ml of 1:1 potassium hydroxide in water and heated at reflux with stirring for 30 minutes. After cooling in an ice bath, the blend was quantitatively transferred into a separation funnel having 50 ml water, 10 ml methyl alcohol, and 50 ml hexane including 1.5 mg/100 ml butylated hydroxytoluene (BHT). The separated funnel was violently shaken for two minutes, allowing the phases to separate. The aqueous phase is eliminated and extracted two times with 20 mL of hexane involving 1.5 mg/100 mL BHT.

The analysis has been carried out using a HPLC system (Agilant Technologies, Germany) 1200 series including a variable wavelength detector (295 nm for V.E, 266 nm for V.D, and 280 nm for V.K) and a waters series 2695 quternary solvent delivery system with a cooled autosampler at 4ºC and a heated column compartment at 30ºC. The compounds were separated using a 10 µm Bondclone 3.9 x 300 mm C18 column (phenomenex, Sydney, Australia) with a C18 guard column. The mobile phase was composed of water and methanol (5:95), with a flow rate of 1 ml/min. [27].

2.3.10. Statistical analysis

The software package SPSS (copy 17, SPSS Inc., Chicago, USA) has been utilized to compare treatment means at a significance level of $p < 0.05$.

3. Results and Discussions

Table 2 shows the approximate composition of several *Al-Dokka* samples collected from various governorates.

Ingredients / Governorate	Moisture%	Protein%	Fat%	Ash%	Crude Fiber%	Carbohydrates%	K. Calories/100g
Cairo	4.1^{f}	23.6^{b}	52.9^{a}	3.6^{d}	7.7^{d}	7.8^{h}	602.1^{a}
Ismailia	5.4^{cd}	24.7^{a}	36.0^{e}	3.4^{e}	8.3^{c}	22.1^{c}	511.2^{f}
Sharkia	5.5^{c}	23.0^{c}	40.5^{c}	3.8^{c}	7.7^{d}	19.5^{d}	534.1^{c}
Qena	5.5^{c}	23.5^{b}	41.4^{b}	3.6^{d}	7.3^{e}	18.7^{e}	541.5^{b}
Gharbia	5.5^{c}	23.7^{b}	41.0^{b}	3.6^{d}	7.3^{e}	18.9^{e}	539.6^{b}
Siwi	5.5^{c}	21.9^{e}	37.5^{d}	3.6^{d}	8.5^{c}	23.0^{b}	517.3^{e}

Alexandria	6.4[a]	21.7[e]	36.2[e]	4.3[a]	7.0[f]	24.5[a]	510.2[f]
Port Said	6.2[b]	22.7[d]	37.9[d]	4.0[b]	6.2[g]	23.1[b]	523.7[d]
Assiut	5.1[e]	21.9[e]	40.9[b]	4.0[b]	11.5[a]	16.7[g]	522.1[d]
Sohag	5.6[c]	22.0[e]	40.3[c]	4.0[b]	10.1[b]	17.9[f]	522.8[d]

A column's means that had a similar superscript did not differ substantially (p>0.05).

Table 2 shows the approximate composition of the *al-dokka* mixtures produced by different governorates in Egypt. As for protein, it is noted that the highest protein percentage was obtained from a sample taken from Ismailia Governorate (24.7%), which may be due to the composition of the sample, which consists of about two-thirds of the volume of peanuts and chickpeas, while sesame constitutes about one-third of the volume. It is known that peanuts contain a protein percentage of about 27.1%, chickpeas contain a protein percentage of about 24.7%, while sesame contains a protein percentage of about 20.14%, and similar results were confirmed by [28]. Here, the nutritional role of *al-dokka* appears, as a snack consisting of 100 grams of *al-dokka* with bread provides about 25 grams of protein, which is equivalent to one-third of the daily protein requirements for an adult weighing 70 kg (ideal weight). The snack also provides a high nutritional value for protein, as it consists of a mixture of essential amino acids that come from three different sources: sesame, peanuts, and chickpeas. It is also noted from the protein data that the difference between the highest protein percentage in a sample from Ismailia Governorate (24.7%) and the lowest protein percentage in a sample from Alexandria Governorate (21.7%) is 3%.

The Cairo Governorate's mixture of sesame and peanuts contains the highest fat percentage of 52.9%, compared to other governorate mixtures. This is likely due to the high fat content in both sesame and peanuts, reaching 52.8% and 53.2%, respectively. [28] reported similar results on sesame and peanuts. It is also noted that increasing the percentage of chickpeas in the sample leads to a decrease in the percentage of fat in it. Despite high oil content in apricot kernel seeds, pumpkin seeds, and zucchini pulp seeds, their low addition percentage in mixtures prevented an increase in fat percentage, as seen in Qena, Gharbia, and Sohag governorates. Ismailia and Alexandria have seen the most significant reduction in fat percentage. Samples with apricot kernels were found to be more clumpy and had an undesirable taste compared to other samples. Apricot kernels may improve liver function and lipid peroxides in rats [29], but they contain amygdalin, a cyanogenic glycoside, which is not recommended for consumption due to potential health risks [30]. Amygdalin is broken down into hydrogen cyanide, glucose, and benzaldehyde by emulsin, a para-glucosidase found in apricot kernels. Consuming ground apricot kernels can release large amounts of cyanide, potentially leading to chronic poisoning in third world areas [31, 32]. Consumption of apricot seeds, fruits, bitter almonds, cassava, and bamboo shoots can lead to the production of cyanide, a potential chronic toxicity threat [33, 34].

The samples showed a close proportion of ash content, ranging between 3.4% and 4.3%. Samples from Assiut and Sohag showed the highest crude fiber content at 11.5% and 10.1%, respectively, which not affecting mouthfeel or texture, while Siwa's 8.5% fiber content had clear roughness and effected on their quality. The mouth's taste and texture were unfavorable due to the fibers derived from date pits, which comprise 15% from date pits weight. Despite The fiber content in Siwa and Ismailia samples was equal, but The fiber in Ismailia sample did not affect the mouth's taste or texture, resulting in a highly desirable taste. The data indicates that the fiber percentage in the samples ranged from 6.2% to 11.5% of the sample composition.

As for carbohydrates, their content ranges between 7.8% and 24.5%. A 100g *al-dokka* snack with 80g local bread provides 17%-20% of daily carbohydrate needs, ranging from 400-500g per adult per day. Consuming a 100g snack (contains 45 fat) with 20g of olive oil provides 65g of fat, a daily intake from fat almost ranged between 50-100g for adults, with some organizations recommending a maximum of 90g. Thus, the body gets about two-thirds of its daily fat needs from this snack.

Considering the calories from this meal, where a loaf of black bread provides 80 grams containing 60 grams of carbohydrates, which gives 240 calories. The addition of 20 grams of olive oil provides 180 calories. The 100 grams of *al-dokka* contain an average of 550 calories, with a range of 517 to 602 calories. This meal gives 970 calories, which represents about a third of an average-effort adult man's need (2800-3000 calories) and almost half of an average-effort adult woman's need (2200 calories).

From this perspective, it becomes clear that Egyptian *al-dokka*, one of the ancient traditional dishes, has a great nutritional value. When we take into account the international health and nutritional guidelines that recommend including sesame, chickpeas and peanuts in the diet, as they are considered functional ingredients that enhance food, it becomes clear to us the importance of these traditional dishes from a nutritional and health perspective (although it is difficult to list their details in this limited context).

Table 3 shows the sensory attributes of various *Al-Dokka* from different governorates.

Ingredients / Governorate	Color	Smell	Taste	Appearance	Texture	Mouth Feel	Overall acceptability
Cairo	7.8^{e}	8.0^{d}	7.8^{e}	8.3^{d}	7.8^{d}	7.0^{g}	7.8^{d}
Ismailia	9.0^{c}	9.5^{a}	9.8^{b}	9.8^{b}	9.0^{b}	9.0^{c}	9.3^{b}
Sharkia	9.3^{b}	9.5^{a}	9.8^{b}	9.8^{b}	9.0^{b}	9.3^{b}	9.4^{b}
Qena	6.8^{f}	8.3^{c}	7.8^{e}	7.8^{e}	6.8^{f}	7.5^{f}	7.5^{e}
Gharbia	7.8^{e}	8.5^{b}	8.5^{c}	8.3^{d}	7.0^{e}	8.0^{e}	8.0^{d}
Siwi	6.5^{g}	8.3^{c}	8.3^{d}	7.0^{f}	6.0^{g}	6.8^{h}	7.1^{f}
Alexandria	9.5^{a}	9.5^{a}	10.0^{a}	10.0^{a}	9.3^{a}	9.5^{a}	9.6^{a}
Port Said	8.5^{d}	8.5^{b}	8.5^{c}	9.0^{c}	8.5^{c}	8.8^{d}	8.6^{c}
Assiut	4.5^{i}	5.0^{e}	4.3^{f}	5.5^{g}	5.3^{h}	4.8^{j}	4.9^{g}
Sohag	4.8^{h}	4.3^{f}	3.3^{g}	5.3^{h}	4.5^{i}	3.8^{k}	4.3^{h}

A column's means that had a similar superscript did not differ substantially ($p>0.05$).

Table 3 summarizes the sensory characteristics of Egyptian *al-dokka* prepared in different governorates. Chickpeas enhanced the color of the mixture, while high proportions of apricot kernels, date kernels, coriander, and cumin in Assiut and Sohagian *al-dokka* led to a deterioration in color. The addition of cumin and coriander in large proportions, as seen in Assiut and Sohagian *al-dokka*, made the smell unacceptable, whereas small quantities were used to control the taste. The addition of cumin and coriander in large amounts, as seen in Assiut and Sohagian *al-dokka*, intensified the taste, while apricot and date kernels also made it unpalatable. Adding cumin, coriander, apricot kernels, and date pits to the dish made its appearance, texture, and mouthfeel unacceptable, particularly regarding fibers (resulting from date pits) and clumps resulting from adding apricot kernels. The unacceptable smell and appearance when apricot kernels are added also affect the overall acceptance. Despite the great health benefits of cumin and coriander when added to the mixture, Assiut and Sohagian *al-dokka* recorded the lowest acceptance rate. So did Siwan *al-dokka* to which date seed were added. Alexandrian *al-dokka* and those imported from Sharqia and Ismailia recorded the highest acceptance rate (9.6, 9.4 and 9.3 respectively). Based on the sensory and nutritional evaluation, we recommend using the mixtures produced from the following governorates: Alexandria, Sharqia, Ismailia, Port Said, Gharbia and Cairo in terms of health and nutritional benefits and sensory characteristics.

Table 4 shows the antioxidant activity and total phenolics, flavonoids, vitamins D, E, and K content of *Al-Dokka* samples collected from several governorates.

Ingredients / Governorate	DPPH	T- Phenols mg/100g	T Flavonoids mg/100g	VD µg/100g	VE mg/10g	VK µg/100g
Cairo	47.8^{e}	128.8^{b}	10.11^{a}	33.4^{c}	16.2^{e}	8.91^{e}
Ismailia	68.4^{c}	120.0^{d}	6.24^{e}	32.8^{c}	17.8^{e}	20.06^{c}
Sharkia	92.9^{a}	114.5^{e}	3.09^{i}	41.6^{b}	24.3^{d}	20.85^{c}
Qena	82.6^{b}	112.8^{f}	6.88^{d}	57.3^{a}	36.1^{c}	23.40^{b}
Gharbia	91.2^{a}	110.5^{f}	3.95^{g}	23.1^{d}	44.9^{a}	27.7^{a}
Siwi	56.3^{d}	118.4^{d}	3.32^{h}	24.0^{d}	40.1^{b}	25.34^{b}
Alexandria	26.4^{g}	119.3^{d}	6.33^{e}	38.4^{b}	41.0^{b}	17.87^{d}
Port Said	31.2^{f}	119.2^{d}	9.64^{b}	57.3^{a}	46.6^{a}	9.09^{e}
Assiut	94.9^{a}	124.5^{c}	4.95^{f}	11.9^{e}	22.2^{d}	18.36^{d}
Sohag	88.4^{a}	147.5^{a}	8.63^{c}	11.4^{e}	19.9^{e}	10.22^{e}

A column's means that had a similar superscript did not differ substantially ($p>0.05$).

The data in **Table 4** show the antioxidant activity and content of total phenolics, flavonoids, vitamins D, E and K in the samples of *al-dokka* taken from different governorates. The samples from Assiut, Sharkia, Gharbia, and Sohag showed the highest antioxidant activity, ranging from 88.4% to 94.9%. In contrast, the samples from Alexandria and Port Said recorded the lowest antioxidant activity with values ranging from 26.4% to 31.2%.

The samples all share a common factor: sesame, which has antioxidant activity due to sesamin and sesaminol compounds, along with vitamin E [35]. Sesamin, a natural antibacterial, antiviral, and anti-inflammatory oil, protects the liver from oxidative damage, increases fat burning, and is used in treating chronic diseases like hepatitis, diabetes, and migraine [36, 37]. Roasted sesame oil, rich in antioxidants, resists rancidity and enhances fried product taste. Oral consumption may inhibit pro-inflammatory cytokine production, protecting against lead and lipopolysaccharide-induced liver injury [38]. Sesamol, a potent antioxidant, has potential therapeutic benefits by scavenging reactive oxygen species and increasing vitamin E recycling. Sesame flour is high in protein, methionine, and tryptophan [39].

The Sohag sample had the highest phenolic content, followed by Cairo and Assiut samples, with each having varying levels of phenolics. The high phenol content in Assiut and Sohag samples is attributed to the increased proportion of cumin and coriander, resulting in increased antioxidant activity.

The Cairo sample had the highest total flavonoids content at 10.11 mg/100 g, followed by Port Said at 9.64 mg/100 g and Sohag at 8.63 mg/100 g. In contrast, the Sharkia sample recorded the lowest content of flavonoids at a rate of 3.09 mg/100 g.

Vitamin D content increased significantly in Qena and Port Said samples, followed by Sharkia and Alexandria samples with 41.6 and 38.4 µg/100 g, respectively. Assiut and Sohag samples had the lowest vitamin D content, with 11.9 and 11.04 µg/100 g, respectively.

As for vitamin E, the highest statistical content was recorded in the Port Said and Gharbia samples with a content of 46.6 and 44.9 mg/100 g, respectively, followed by the Alexandria and Siwa samples with a content of 41 and 401 mg/100 g, respectively, without statistical differences between them. In contrast, the samples with the lowest vitamin E content were those taken from Cairo, Ismailia and Sohag with a content of 16.2, 17.8 and 19.9 mg/100 g, respectively, without statistical differences between them.

As for vitamin K, the highest content was recorded in the Gharbia sample, which may be due to the high percentage of pumpkin seeds, followed by the Siwa sample, which contains dried date pits, and then the Qena sample, which contains apricot pits. In contrast, Cairo, Port Said and Sohag samples recorded the lowest vitamin K content statistically with contents of (8.91, 9.09 and 10.22 µg/100g).

Sesame is included in all prior formulations in substantial quantities and has a major influence on the level of antioxidants and vitamins, because it includes numerous useful components [14, 40, 41, 42, 43, 44].

Table (5). Fatty acid composition (% oils of sample) extracted from different sample of *Al-dokka*

Governorate / Fatty Acid	Cairo	Ismailia	Sharkia	Qena	Gharbia	Siwi	Alexandria	Port Said	Assiut	Sohag
	Area%	Area%	Area%	Area%	Area%	Area%	Area%	Area%	Area%	Area%
	Saturated Fatty Acids (SFA)									
Lauric acid C12:0						**0.68**			**0.66**	**0.56**
Myrstic acid C14:0	0.04	0.07	0.04	0.05	0.16	0.39	0.03	0.06	0.12	0.11
Palmitic acid C16:0	9.66	9.70	9.48	9.03	10.17	9.77	9.58	10.48	9.28	7.74
Margaric acid C17:0	0.07	0.12	0.06	0.06	0.06	0.07	0.05	0.06	0.06	0.04
Stearic acid C18:0	4.19	4.24	4.94	4.63	5.40	4.76	6.03	6.43	4.56	4.28
Arachidic acid C20:0	1.02	0.90	0.88	0.77	0.69	0.77	0.62	0.59	0.93	0.44
Behenic acid C22:0	1.58	1.34	0.94	0.99	0.79	1.52	0.12	0.15	0.79	0.09
Toatal saturated fatty acid (TSFA)	16.56	16.38	16.35	15.53	17.26	17.96	16.44	17.77	16.40	13.26
	Mono unsaturated Fatty Acids (MUFA)									
Palmitoololeic acid C16:1	0.10	0.11	0.12	0.10	0.06	0.11	0.14	0.13	0.13	0.29
Hepatadeccunoic acid C17:1	0.05	0.08	0.04	0.03	0.03	0.04	0.03	0.03	0.04	0.07
Oleic acid C18:1	44.04	42.65	42.50	37.25	37.11	41.90	40.38	41.24	46.66	52.22
Gadoleic acid C20:1	0.93	0.73	0.57	0.51	0.42	0.60	0.20	0.20	0.57	0.18
Toatal Mono unsaturated Fatty Acids (MUFA)	45.11	43.57	43.22	37.90	37.62	42.65	40.75	41.60	47.39	52.76
	Poly unsaturated Fatty Acids (PUFA)									
Linoleic acid C18:2	38.03	39.42	40.05	36.76	44.81	39.03	41.48	40.27	35.96	32.44
Linolenic acid C18:3n3	0.30	0.63	0.38	9.72	0.32	0.36	0.44	0.36	0.26	0.24
Toatal Poly unsaturated Fatty Acids (TPUFA)	38.33	40.05	40.43	46.49	45.13	39.39	41.92	40.63	36.21	32.68
Total unsaturated Fatty Acids (TUFA)	83.44	83.62	83.65	84.38	82.74	82.04	82.67	82.23	83.60	85.44
Total Fatty Acids (TFA)	100	100	100	100	100	100	100	100	100	100

A column's means that had a similar superscript did not differ substantially (p>0.05).

The data in **Table (4)** showed that palmitic acid was the main component of saturated fatty acids (SFAs) in the different samples, followed by stearic acid in terms of percentage. The sample taken from Siwi recorded the highest percentage of saturated fatty acids (17.96%) compared to the sample taken from Sohag, which recorded the lowest percentage of saturated fatty acids (13.26%). On the other hand, oleic acid was the most abundant component among monounsaturated fatty acids (MUFA). The sample taken from Sohag recorded the highest percentage of monounsaturated fatty acids (52.76%), while the sample taken from Gharbia recorded the lowest percentage (37.62%). The sample taken from Qena also recorded the highest percentage of polyunsaturated fatty acids (46.49%) compared to the other samples, while the sample taken from Sohag recorded the lowest percentage (32.68%). The sample taken from Sohag recorded the highest percentage of total unsaturated fatty acids (TUFA), while the sample taken from Siwa recorded the lowest percentage (82.04%). It is noted that the content of total unsaturated fatty acids in all samples taken from different governorates ranged between 82.04% and 85.44%, and these high percentages reduce the risk of coronary heart disease in humans. These results are consistent with the recommendations of [43] regarding increasing the consumption of total unsaturated fatty acids and reducing saturated fats.

4. Conclusion

The research aims to evaluate the nutritional value of Egyptian *al-dokka* mixtures, and highlight its importance as a popular food with high nutritional value, especially in light of rising prices and food shortages. The components of *al-dokka* vary between regions and families, and include ingredients such as sesame, peanuts and chickpeas, and it is recommended to use them as functional materials in food fortification. Eating 100 grams of *al-dokka* with a loaf of black bread and 20 grams of olive oil provides a large percentage of the daily calories, protein, fat and carbohydrates for adults. The results also showed an increase in the content of antioxidants, phenolic compounds and unsaturated fatty acids. However, the high percentages of ingredients such as apricot kernels, dates, coriander and cumin in some regions lead to a deterioration in sensory properties. Based on the sensory and nutritional evaluation, it is recommended to use the mixtures produced from governorates such as Alexandria, Sharkia, Ismailia, Port Said, Gharbia and Cairo, due to their health and nutritional benefits and sensory properties.

Ethical Approval:

As per international standards or university standards written ethical approval has been collected and preserved by the author(s).

Disclaimer (Artificial intelligence)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

Competing interests

Authors have declared that no competing interests exist.

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