IMPACT OF GREEN PARTS POWDER OF LOCALLY CULTIVATED CARROT (*DAUCUS CAROTA* L.) ON QUALITATIVE AND SENSORY PROPERTIES OF BISCUITS AND CAKE

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ABSTRACT

The current study aimed to identify the effect of adding different concentrations (0%, 1%, 2%, 3%, and 4%) of carrot green parts powder (CGP) into biscuit and cake mixes on final products qualitative and sensory characteristics. The chemical analysis showed that the protein, ash, and fiber contents for wheat flour and for CGP were (10.64%, 0.88%, and 0.48%) and (16.4%, 19.4%, and 18.65%) respectively. While for the final products the percentages of protein and ash ranged from (10.36% - 12.80% protein, 1.03%-1.53% ash) for cake treatments and (13.00 % -20.00% protein, 0.92%-1.43%ash) for biscuits treatments respectively. There was no significant variation among the width averages of biscuit treatments. The highest value for both spread ratio and spread factor were seen in treatments with 2 and 3% added powder. The sensory evaluation analysis indicated that there were no notable differences among the treatments in terms of external characteristics (the nature of surface and crust color). Although the internal characteristics were significantly affected by CGP concentrations, the overall scores for acceptance of the final product showed no significant differences among treatments. Regarding the cake samples, there were no significant differences in external characteristics among the treatments, except the color of the crust for treatment with 2% CGP and the crumb texture (porosity) and the overall acceptance in treatments with 1 and 2%of CGP which showed, significant differences.

Keywords: carrots Vegetative parts, biscuits, fiber, sensory evaluation.
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تأثير إضافة مسحوق الاجزاء الخضراء لنبات الجزر المزروع محلياً (*Daucus carota* L.) على الصفات النوعية والحسية للبسكويت وكيك الاقداح

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المستخلص

هدفت الدراسة الحالية الى التعرف على تأثير إضافة تراكيز مختلفة (0، 1، 2، 3، 4) % من مسحوق الأجزاء الخضرية للجزر الى الخلطة المجهزة لصناعة البسكويت والكيك المختبري على الصفات النوعية والحسية لهما. أظهرت نتائج التحليل الكيميائي ان نسبة البروتين والالياف الكلية والرماد لدقيق الحنطة ولمسحوق الاجزاء الخضرية للجزر كانت (10.64، 0.48، 0.88 %) و (16.49، 18.65، 19.4 %) على التوالي. في حين كانت نسبة البروتين والرماد في المنتجات النهائية تتراوح (10.36–12.80% للبروتين و1.03– 1.53% للرماد) في معاملات البسكويت و(13.00–20.00% و0.92 –1.43%) على التوالي لمعاملات الكيك وتباينت معدل عرض أقراص معاملات البسكويت بزيادة نسبة الإضافة وسجلت المعاملتان بنسبة اضافة 2 و3 % أعلى قيمة لنسبة ولمعامل الانتشار. وبينت نتائج التقييم الحسي عدم وجود فروق معنوية بين المعاملات بالصفات الخارجية (تشقق السطح ولون القصرة) في حين تأثرت الصفات الداخلية وبشكل معنوي مع اختلاف نسب الاضافة، ولم تتأثر مجموع درجات التقبل العام للمعاملات بشكل معنوي. وفيما يخص معاملات الكيك لوحظ تحسن غير معنوي في الصفات المظهرية مع رفع نسبة الاضافة باستثناء صفة لون القصرة عند تركيز 2% وصفة نسجه اللب والتقبل العام عند التركيزين 1و2% فقد كانت الفروقات معنوية.

الكلمات المفتاحية: الاجزاء الخضرية للجزر، البسكت، الألياف، التقييم الحسي.
جزء من اطروحة الدكتوراه للباحث الاول

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INTRODUCTION

The preparation and processing of fruits and vegetables result in significant quantities of organic waste, which is generally inexpensive. Improper management of this waste may lead to environmental harm. Hence, it is crucial to utilize these low-calorie by-products, which are abundant in dietary fiber, vitamins, and mineral elements, to modify the physical and chemical characteristics of various food items (2,4). This includes their application in partially substituting flour, fats, or sugars, acting as a moisture stabilizer and fat retainer, as well as enhancing emulsifying properties (22,18). Therefore, they are considered a source for many food and therapeutic industries, as is the case for many wastes thrown away daily without benefiting from them (23). Carrot *(Daucus carota* L.*)* belongs to the family Apiaceae and vegetative components are regarded as significant food waste due to their low cost and great nutritional value, particularly their abundance of carotene and other nutrients (1, 45). Due to its substantial content of dietary fiber, it aids in reducing cholesterol levels and serves as a unique source of mineral molybdenum, which is seldom found in other vegetables. During the process of metabolizing carbs and lipids, as well as absorbing iron, it also contains significant amounts of magnesium, manganese, and several other minerals (26,20). Carrots are a multi-nutritional food source and are rich in natural bioactive compounds, such as phenolics, carotenoids, polyacetylenes, ascorbic acid, fiber, and minerals (3). Carrot powder added to the recipe enriches the product with natural vitamins, because of the concentration of the coloring pigment carotene (41, 37). It is a nutritious root vegetable, which is not available throughout the year. Drying the carrot could efficiently extend its shelf life. Many parts of various plants (waste), such as roots, fruit, and leaves are discarded by consumers and the food industry because of the lack of knowledge and appropriate processing technology, however, waste is used as an alternative, low-cost source of nutrients to increase the nutritional value of the diet of poor people. Carrot leaves, for example, can be added to soups, bakery, etc (30, 41). Studies have shown that dehydrated carrot leaves can be added to different dishes, juices, and processed products as an alternative source of antioxidants and nutrients in food (30). Drying fruit, vegetables, and leaves is a common way of preserving powders to prepare quick food. This technology for fruits and vegetables is an essential ingredient in many products, including instant cupcakes, soups, cookies, healthy snacks, and ready-to-eat powdered drinks (31,44) . There are several advantages of eating a healthy fiber-rich diet, such as avoiding constipation, blood sugar regulation, the reduction of excessive cholesterol, and the prevention of several malignancies (49,47). Biscuits designed to cater to the specific health and therapeutic requirements of different human sectors need the addition of fortifiers that augment their protein, fiber, mineral, and vitamin content, hence enhancing their nutritional characteristics. it is the most popular bakery product consumed and the most popular bakery product consumed worldwide as a snack food on a big scale in poor nations where protein-energy malnutrition is common because they are ready to eat, inexpensive, nutritionally dense, readily available, and have a longer shelf life. Cakes are always readily available and kids love them.(39; 29). Cereal crops dominate human food production globally due to their adaptability to various climates and soil conditions. Cereal crops provide approximately three-quarters of an individual's energy requirements and over half of their protein needs. They serve as a safety mechanism. This guarantees global food security and stability (8, 34). To do this, promote diversity in food production at the national and household levels by growing indigenous food crops that are suitable for the specific location and using all sections of the plant for maximum advantage (34, 48). Recently, researchers have focused on consuming low-calorie, high-fiber foods to promote health and prevent disease (16,14). The study sought to utilize the discarded vegetative parts of the carrot plant, which were considered insignificant waste, by substituting a portion of the refined wheat flour in biscuit mixes and cupcakes. The objective was to create a product that is high in dietary fiber and protein while maintaining quality characteristics that are acceptable to consumers. This approach not only offers health benefits but also reduces waste.

MATERIALS AND METHOD

Preparation of carrot green parts powder

The wild carrot *(Daucus carota L.*) was collected, in February (2022), from the area of Tarmiya (Baghdad-Iraq). After harvest, the stems and leaves were separated and shade-dried in an incubator at 40°C. Then, they were ground in a spice grinder (Silver Crest brand, China), sieved through 250 µm sieve and the obtained powder was stored at 4 °C until use.

Chemical composition analyses of wheat flour, carrot green parts powder, Biscuit and cupcake:

The chemical composition, as included moisture, ash, protein, and fat, were analyzed using the established procedures outlined in The American Association of Cereal Chemists (AACC) (12) with the symbols (19-44), (30-25), (46-11), and (01-8). The total carbohydrate content was determined by calculation. By subtracting the sum of these approximated elements from 100.

Biscuit preparation: Biscuits were prepared according to the method approved by the (AACC)(10) with the code (10-50B) described by Al-Mehyawi (9). The following ingredients were used: 225 g of wheat flour (Alfakhir), 130 g of powdered sugar, 64 g of margarine butter, 2.1 g of table salt, 2.5 g of sodium bicarbonate, 33 ml of glucose solution, and wheat flour replaced by 1%, 2%, 3% and 4% of carrots vegetative parts powder.

Carrot green parts and wheat biscuit treatments: white all-purpose wheat flour labeled as "Alfakhir " was replaced by above mentioned ratios of carrot vegetative parts and the treatments designated as explained below:

WB0: (Control) consisting of the basic ingredients. **CB1**, **CB2, CB3 and CB4 are** consisting of basic ingredients with 1%, 2%, 3% and 4% substitution of wheat flour with green parts carrot powder.

Cupcake preparation: Cupcake were prepared according to the method approved by the (AACC) (11) with the code (10-90B) described by (24) with some modification. The basic ingredients included the following: Alfakhir wheat flour 130 g, sugar 85 g, dry milk powder 7 g, margarine butter 57 g, eggs 57, vanilla 5 g, salt 2 g, vinegar 1 ml, cake improver 12.5 g, baking powder 5 g. The control treatment was prepared by adding 110 ml of water, while for the remaining treatments the added water increased to 120 ml. Meanwhile the wheat flour partially replace by carrots vegetative parts powder at ratios of 1%, 2%, 3% and 4%. The treatments symbolled as following

WK0: (Control) consisting of the basic ingredients. **CK1, CK2, CK3 and CK4** consist of basic ingredients with 1%,2%,3% and 4% substitution of wheat flour by carrot green parts powder.

Physical properties of standard biscuits

Measurement of thickness, diameter, and spread factor: The physical parameters, including diameter, thickness, and spread factor, of the laboratory biscuits were determined using the AACC procedure (10) as described by (9).

$$\frac{\text{Average width of 6 biscuits}}{\text{Average thickness of 6 biscuits}} = \textbf{Spared ratio}$$

$$\textbf{Spared factor} = \frac{\textbf{The spread ratio of the treatment under trial}}{\textit{Control treatment spread ratio}} * \textbf{100}$$

Sensory evaluation of biscuits treatments:

The evaluation form described by (7) was followed to evaluate the sensory properties of laboratory biscuits by ten evaluators from food science department.

Physical characteristics of the cake

Specific volume measurement: The method described by (9) was followed to estimate the volume of the cake pieces based on the method of displacing the rape seeds, and then the cake pieces were weighed. The specific volume (permeability) was calculated by applying the following equation:

Specific volume (cm3/g) = Volume of displaced rape seeds (cm3) / Weight of cupcake (g): The cake pieces with the highest specific size were given a score of 30 on the grading scale of the sensory evaluation table, and the remaining pieces were scored on the basis of this piece.

Measuring the density of the cake pieces: The density of the cake pieces was estimated according to (43) by dividing the weight of the cake (g) by the volume of the cake (cm3), according to the following equation:

Cake density (g/cm3) = weight / volume

Measurement of weight loss (%) after baking: The percentage of weight loss after baking was determined according to the method described by (8) using the following equation:

$$\mathbf{W.\ L.\ \%} = \frac{\mathbf{W.Cp.B.B. - W.Cp.A.B}}{\mathbf{W.Cp.B.B.}} \boldsymbol{x}\ \mathbf{100}$$

W.L.=weight loss, W.Cp.B.B.=weight of the experimental cake pieces before baking, W.Cp.A.B= weight of the same cake pieces after baking.

Sensory evaluation of cake: The sensory evaluation for the experimental cake was done using the evaluation form which mentioned by (24).

Measurement of color degree of Biscuit and cake: The color degree of the experimental biscuit and cake pieces were measured using a Lab colorimeter (The Lab colorimeter utilizes the International Commission on Illumination) according to the method described by (33) and (8). (CIE) color scales, expressing color values as luminance (L*), red-green axis (a*), and yellow-blue axis (b*), recorded directly from the color measurement device at a calibrated rate.

Statistical analysis: The Statistical Analysis System (SAS) program (42) was applied for data analysis to point out the impact of different factors on the evaluated characteristics using a Completely Randomized Design (CRD). The significant differences among means were compared using the Least Significant Difference (LSD) test.

RESULTS AND DISCUSSION

Chemical composition of raw materials

The chemical composition of wheat flour and powdered carrot vegetative parts are shown in Table (1). The moisture content of the flour was 11.62%, being within the desired range (11.5–15.2%) for bakers. The percentage of moisture is a critical factor in determining flour quality and the rate of water absorption of flour (9). The protein content was 10.64%, this value is lower than Kazim etal. ;(27) finding (10.80%), while it was consistent with the findings of (35) (10.64%). Al-Mihyawi (9) mentioned that the protein percentage in soft wheat typically ranges from 9–12%. The protein content of grain regarded as a fundamental indicator of the quality of wheat grains, and it is affected by environmental, genetic factors, meteorological and agricultural circumstances. Wheat varieties that are cultivated in the fall and winter, particularly in Northern Europe, dominate the growth stage. These types are known for yielding grains that are softer and have lower protein content. This variety is referred to as soft wheat, its gluten has reduced extensibility (elasticity). The chosen type for biscuit production is also more cost-effective because of the direct correlation between the price of wheat and its protein level. The protein content in biscuits typically ranges from 8.5% to 10.5%, but cake and flaky desserts like kahi and baklava are normally made with flour containing less than 8.5% protein (9, 31, 40). As listed in Table (1) the flour fat content was 2.00%. It was lower than (27) findings (2.45%) and consistent with the results reported by (35) (2.00%). The latter emphasized that the flour fat content has significant effect on the rheological characteristics of dough, despite its relatively low content compared to other components. Table (1) also shows that the ash percentage (0.88%) was higher than that reported by (27) 0.45%, and similar to the value reported by (35) 0.88%. The ash content is mostly influenced by the quantity of bran present in the wheat grain, often expressed as a percentage ranging from 0.4% to 2.0%. The calculation is based on a moisture content of 14% (6). Al-Mehyawi (9) stated that the ash percentage is a valuable measure for assessing the effectiveness of grinding operations and serves as an indication of the color variation in flour. Usually, biscuits manufactured from flour with a high ash content often exhibit a darker shade. The wheat flour which used in this study had a low amount of fiber (0.48%) and this is similar to the one used by (35) (0.48%). While (27) found the percentage of fiber in the flour was 0.75%. The carbohydrates percentage (74.38%) in this study was higher than (27) findings (73.05%), but lower than that reported by Nasser et al. (35) (75%). As (9), is stated the typical amount of carbs in wheat is around 65-75%, which is parallel with carbs of the flour used in this study. The variations in the amount of chemical constituents in different kinds of wheat flour may be attributed to the variation in both the genetic characteristics of the wheat varieties and the environmental conditions. Cultivated inside it is an assortment of meticulously formulated blends tailored specifically for the intended objective (9).

Table 1. chemical composition analysis of wheat flour and carrot green parts Powder

Chemical Composition	Dry matter	Moisture	Ash	Fiber	Protein	Fat	CHO.
Wheat Flour	88.38	11.62	0.88	0.48	10.64	2.00	52.93
Carrot green parts powder	92.76	7.24	19.4	18.65	16.49	2.75	74.38

The data presented in Table 1 shows that the moisture, protein, fat, ash, fiber and carbs content of carrot green parts powder were 7.24%, 16.49%, 2.75%, 19.4%, 18.65%, and 52.93% respectively. Goneim *et al.* (20), found the chemical composition of carrot leaves powder was 9.15% moisture, 20.27% protein, 3.37% fat, 15% ash, and 61.36% carbs. Leite *et al.* (30) reported that the moisture, protein, fat, and ash percentages in dried carrot leaves were 5.73, 18.23, 4.75, and 15.32%, respectively. These values in both articles were higher than the values obtained in this research, except for moisture. While (19) found that protein in the mallow powder was (8.70 g/100 g DM) which is lower than the value obtained in this study and the sensory evaluation at a 3% level has remained acceptable.The composition and levels of the constituent elements depend on the arrangement of plant tissues, which leads to differences in dry matter content among various plant species, in addition to the fact that low humidity led to an increase in the rest of the chemical components, which can be a positive aspect when trying to increase the nutritional value of food (27). Ceylan and Yucel (15), and Özer and Aksoy (37), stated that the nitrogen content in plants has significant importance and exhibits variability based on factors such as plant species, climatic conditions, and soil composition. Vegetables are considered the optimal dietary option due to their significant content of total fiber. This is primarily attributed to their status as edible components of plants or their extracts. Moreover, due to their limited digestibility or absorption in the small intestine, vegetables typically undergo complete or partial fermentation in the large intestine, (28). Additionally dietary fibers are defined as carbohydrate polymers that are linked to ten or more monomers of glucose. These polymers are resistant to degradation by enzymes found in the small intestine of humans and possess various physical and chemical properties that contribute to their functional behavior. These properties include solubility, fermentation, viscosity, and water absorption (37).

Chemical analysis of biscuits and cakes

Table (2) displays the percentage of protein and ash in experimental biscuit and cake samples. It has been seen that the percentages of both components increases as the replacement percentage increases in comparison to the control treatment WB0, WK0 which recorded the lowest values. The increase in the percentage of protein and ash in manufactured products is due to the partial replacing of wheat flour by carrot green parts powder to the mixture prepared for each product. According to (36) was stated that mixing defatted macrotermes subhyalinus Flour(DMF) with wheat flour to make biscuits, the percentage of protein increased from 08.33% to 20.13%.

Table 2. Percentages of protein and ash in biscuits and cupcakes samples manufactured from wheat flour with different ratio of carrot green parts powder

Chemical composition of Biscuit			Chemical composition of cupcake		
Treatments	Protein%	Ash%	Treatments	Protein%	Ash%
WB0	11.90	0.85	WK0	9.80	0.92
CB1	13.00	0.92	CK1	10.36	1.03
CB2	16.00	1.09	CK2	11.36	1.21
CB3	19.00	1.13	CK3	11.97	1.46
CB4	20.00	1.43	CK4	12.80	1.53

WB0: (Control biscuit treatment) consisting of the basic ingredients. CB1, CB3 and CB3 and CB4 are basic ingredients with 1%, 2%, 3% and 4% substitution of wheat flour by carrot green parts powder respectively. WK0: (Control cupcake treatment) consisting of the basic ingredients. CK1, CK2, CK3 and CK4 basic ingredients with 1%, 2%, 3% and 4% substitution of wheat flour by carrot green parts powder respectively.

The physical properties of experimental biscuits and cake: Table (3) illustrates the physical properties of the biscuits samples produced by replacing part of wheat flour by carrot green parts powder, including thickness, diameter, spread ratio and spread factor. The results showed significant differences (P≤0.05). among the treatments thickness and spread ratio as compared to control . No significant variations were observed among the treatments in term of width and the values ranged from 27.0 to 90.50 cm. In contrast the spread ratio and spread factor were recorded significant variations between CB2 ,CB3 and CB0, CB1. The data demonstrates that the spread factor value had an upward trend as the addition rate rose.

Table 3. Effect of partial replacing of wheat flour by carrot green parts powder on some characteristic of biscuit and cake samples

The physical properties of biscuits					The physical properties of cake			
Treatments	Width rate	Thickness rate	Spread ratio	Spread factor	Treatments	Weight before baking gm	Weight after baking gm	% Weight loss after baking
WB0	28.00	3.20[a]	8.75[b]	100[b]	WK0	467	412.86	11.59[b]
CB1	28.40	3.20[a]	8.88[b]	101.43[b]	CK1	477	415.88	12.81[ab]
CB2	29.50	2.90[ab]	10.17[a]	116.26[a]	CK2	477	416.72	12.64[ab]
CB3	27.80	2.70[b]	10.30[a]	117.67[a]	CK3	477	405.12	15.07[a]
CB4	29.40	3.10[ab]	9.48[ab]	108.39[ab]	CK4	477	419.54	12.05[ab]
L.S.D.	2.07N.S.	0.466*	1.367*	10.521*	L.S.D.	11.84NS	15.66NS	3.169 *
				(P≤0.05) *				

WB0: (Control biscuit treatment) consisting of the basic ingredients. CB1, CB3 and CB3 and CB4 are basic ingredients with 1%, 2%, 3% and 4% substitution of wheat flour by carrot green parts powder respectively. WK0: (Control cupcake treatment) consisting of the basic ingredients. CK1, CK2, CK3 and CK4 basic ingredients with 1%, 2%, 3% and 4% substitution of wheat flour by carrot green parts powder respectively

Ahmad et.al (3) found the width, thickness, and spread ratio of biscuits were differ depending on the type of added vegetable parts. All treatments showed higher values compared to the control treatment, except for sweet potatoes at a concentration of 10%, which had a lower value. Another study (46) used carrot pomace powder (CPP) and germinated chickpea flour (GCF) in making biscuits, where it was observed that the spread ratio of biscuits samples increased from 6.1 to 8.4 with an increase in the(CPP) and (GCF) in the blend. Also, Table (3) indicates the values of the weights of cake pieces before and after baking, the percentage of moisture loss after baking, and the amount of moisture retention. There were no significant differences among the weights of cake pieces before and after baking. Treatment Ck3 recorded the highest percentage of weight loss after baking, followed by the rest treatments, which did not differ significantly as compared to the control treatment WK0, which assure the ability of these additives to retain moisture and maintain the freshness of cake pieces for the longest period. The results of this study agreed with what was shown by (29) that there were no significant differences in the weights of cake pieces, meanwhile there was a continuous decrease in the volume of cake pieces as the percentage of replacing flour with green tea leaf powder increased. They suggested that a perfect cake mixture must maintains sufficient viscosity to enable the air bubbles expanding properly before the cake is cooked. Thus the cake structure become well aerated. The reason for the decreases in cake volume with an increase in the ratio of replacing was due to the increased fiber content (cellulose), which weakens the gluten matrix responsible for retaining gases in baked foods.

Colorimetric assay examination of biscuit and cake pieces: Table 4. demonstrate the color attributes of the crust and crumb of biscuit manufactured from wheat flour with and without carrot vegetative parts powder. The addition of carrot green parts powder to the biscuit mixture resulted in the production of biscuit with a darker crust color compared to the control. This led to a decrease in the degree of whiteness (L*) for the crust color and the crumb, and the lowest value observed in treatment CB3, where the addition level was 3%. The crumb recorded variable degrees of whiteness for WB0, CB1, B2, CB3 and CB4, being 67.41, 58.66, 62.89, 55.01, and 62.82, respectively. The (a*) values for the biscuit treatments were 4.07, 6.21, 1.15, 6.52, and 1.66, respectively. Treatment CB3 gained the highest value. The treatments exhibited notable variations, particularly in the extent of yellowing (b*). The biscuit samples made of basic ingredient with and without vegetative parts of carrots recorded these values 19.24, 21.35, 26.63, 16.46, and 25.98, respectively. Treatment CB3 showed a considerably lower value as compared to the other treatments.

Table 4. Color characteristics of the crust and crumb of biscuit and cupcakes made from wheat flour and partial replacing ratio by carrot green parts powder based on the laboratory color scale

Treat.	Biscuit color							
	Crust color				Crumb color			
	L*	a*	b*	L*\b*	L*	a*	b*	L*\b*
WB0	71.12 [a]	4.29 [b]	24.42 [a]	2.91 [a]	67.41 [a]	4.07 [b]	19.24 [bc]	3.50 [a]
CB1	60.21 [b]	6.19 [a]	24.62 [a]	2.45 [ab]	58.66 [b]	6.21 [a]	21.35 [b]	2.75 [ab]
CB2	59.67 [b]	5.97 [a]	27.18 [a]	2.20 [b]	62.89 [a]	1.15 [c]	26.63 [a]	2.36 [b]
CB3	31.41 [d]	0.89 [c]	11.19 [b]	2.81 [a]	55.01 [b]	6.52 [a]	16.46 [c]	3.34 [a]
CB4	53.30 [c]	6.33 [a]	25.83 [a]	2.06 [b]	62.82 [a]	1.66 [c]	25.98 [a]	2.42 [b]
L.S.D	6.02 *	1.788*	4.593*	0.703*	5.734*	1.935*	3.677*	0.891*
	Cake color							
Treat.	Crust color				Crumb color			
	L*	a*	b*	L*\b*	L*	a*	b*	L*\b*
WK0	57.63	8.01	25.70	2.24	77.37	2.88	14.15	5.47
CK1	59.51	7.35	26.60	2.24	62.90	2.17	15.25	4.12
CK2	59.54	4.30	23.17	2.57	67.10	0.86	19.67	3.41
CK3	54.72	4.90	22.86	2.39	64.40	4.12	22.10	2.91
CK4	55.13	5.62	24.27	2.27	58.97	0.70	21.76	2.71
L.S.D.								
	(P≤0.05) *							

WB0: (Control biscuit treatment) consisting of the basic ingredients. CB1, CB3 and CB3 and CB4 are basic ingredients with 1%, 2%, 3% and 4% substitution of wheat flour by carrot green parts powder respectively. WK0: (Control cupcake treatment substitution) consisting of the basic ingredients. CK1, CK2, CK and CK4 basic ingredients with 1%, 2%, 3% and 4% of wheat flour by carrot green parts powder respectively.
L*= degree of whiteness, a* = redness (hue from green to red), b*= yellowness (hue from blue to yellow), the resultant ratio of the degree of whiteness to yellowness L*/b*

The treatments under study in Table (4) exhibited variations in the degree of whiteness of the crust color. The values (L*) recorded for treatments WB0, CB1, CB2, CB3, and CB4 were 71.12, 60.21, 59.67, 31.41, and 53.30, respectively. Treatment CB1 had the greatest values, while treatment CB3 had the lowest. The presence of pigments in the added powder influenced the brightness of the crust color, it become less shiny (darker) as the replacement ratio increased. Treatment CB4 achieved the greatest value of 6.33 for the degree of crust redness (a*), whereas the values for treatments CB0, CB1, CB2, and CB3 were 4.29, 6.19, 5.97, and 0.89, respectively. Regarding the crust yellowing (b*) degrees for the same treatments, the values were 24.42, 24.62, 27.18, 11.19, and 25.83, respectively. There were no notable variations seen, except for treatment CB3. It has been noticed that replacing wheat flour with carrot green parts powder resulted in a notable alteration in the whiteness index L* and yellowness b*, as well as in the ratio of

L*/b* for the color of the crust and crumb in all treatments, as compared to the control. The color of the crust, which is rather greenish compared to the control is generated during the baking process by two specific processes, millard reactions and caramelization. These processes result from the interaction of the ingredient's components. Asadi et al. (13) observed that the colors of the experimental biscuits were changed depending on the type of vegetable added. The highest color variation was observed when spinach was used, while the best color was achieved when carrot pomace was added (25), compared to the control treatment. This color change also led to an increase in the darkness of the biscuits. Additionally, the sensory evaluation of the biscuits decreased due to an increase in hardness and strength. The variations in sensory acceptability were directly linked to the quantity of vegetative parts powders included, in this study replacing by 5% showed higher acceptance compared to 10% and 15% replacing. The results of the cakes presented in Table (4) indicate that there were no significant differences ($P<0.05$) in the degree of whiteness (L*) among the cake treatments WK0, CK1, and CK2. However, significant differences were seen in the remaining treatments, and no significant differences were recorded between the WK0 treatments. CK1 and CK4 are in the degree of yellowing (b*). Adding carrot green parts powder did not affect the total values of (L*/b*), as there were no significant differences among the treatments. Thus, the cake pieces maintained the desired short color. It has been noted that the inclusion of components of the carrot green parts powder had a significant effect on the degree of whiteness (L*) of the cake crumb color, as it became darker with increasing the replacing ratio. The effect of this phenomenon was directly reflected on the values of (*L*/b). The results of this study agreed with Dos Santos et al. (17) results who stated that adding leave powder resulted in presence of green spots (which confer staining), due to the presence of pigments in the leaves, and this led to a decrease in the luminosity parameter (L*), which caused the cake to darken. The results of this study also agreed with (29) who showed that with a decrease in the color shades of shortbread and sponge cake cores with an increase in the percentage of replacing flour with green tea leaf powder. The reason for the discoloration of baked products is related to the fact that leaf pigments and polyphenolic compounds undergo an oxidation reaction (5), and sucrose as well as the rest of the ingredients involved in manufacturing also participate in caramelization and millard reactions during the baking process (33).

Sensory evaluation of biscuits and cakes

Table (5) displays the sensory attributes of the standard biscuits and biscuit treatments. These attributes include external characteristics such as appearance, the nature of surface, softness, color of crust and spread factor, as well as internal characteristics like crumb color, aroma and taste. The treatments exhibited non-significant variations ($P\leq0.05$) in the nature of surface and the color of the crust. However, there were a significant difference among the treatments in all external and internal characteristics. Table 5 indicates that there was a general improvement in all features as the replacement ratio increased as compared to the control treatment. The external appearance significantly improved and became more consistent in treatments CB1, CB2, and CB3, in comparison to the control treatment CB0. Treatment CB4 had the lowest external appearance value, and the highest values in the softness attribute, with no significant variations compared to the control treatment WB0. Whilst the other treatments showed significant variances in this attribute when compared to both the CB4 and WB0 treatments. Table 5 indicates that the perceived internal characteristics, such as crumb color and aroma and taste significantly improved with an increase in the replacement ratio. As an example, treatment CB4 had the most elevated crumb color values, which decreased progressively as the replacement percentage decreased. In contrast, Treatment CB2 had the lowest values and did not demonstrate any notable distinctions from the other treatments. Regarding the aroma characteristic, it was observed that it improved as the substitution ratio increased until the maximum values were reached in treatment CB3. After that, it showed significant differences compared to the other treatments. The overall score did not exhibit statistically significant variations among the treatments. However, all treatments got higher scores than the control treatment WB0, which suggests that adding carrot vegetative parts to biscuits improves the taste and over all acceptance. Treatments CB2 and CB3 had the greatest overall sensory acceptability score, indicating that the replacing by 2% and 3% are the most optimal.

Table 5. Sensory evaluation of biscuit and cake samples made from wheat flour with different replacing ratio of flour by carrot green parts powder

Sensory evaluation of standard biscuit							
Properties	**Degree (%)**	**WB0**	**CB1**	**CB2**	**CB3**	**CB4**	**L.S.D.**
Appearance	20	17.20 ^{ab}	19.00^{a}	18.80 ^{ab}	18.57 ^{ab}	16.80^{b}	2.107 *
The nature of surface	10	8.80	9.00	9.20	9.00	8.40	0.894 N.S.
Color of crust	5	3.54	4.20	3.77	4.82	5.00	1.673 N.S.
Softness	10	8.80^{ab}	7.80 ^{b}	8.20 ^{b}	8.14 ^{b}	10.00^{a}	1.256 *
Aroma and Taste	20	18.00 ^{a}	18.60 ^{a}	19.60 ^{a}	17.14 ^{b}	17.80^{ab}	2.078 *
Color of crumb	5	3.45 ^{ab}	3.92 ^{ab}	3.37 ^{b}	4.77 ^{a}	5.00 ^{a}	1.237 *
Spread factor	30	27.97 ^{ab}	25.86 ^{b}	30.00 ^{a}	30.00 ^{a}	25.81 ^{b}	3.462 *
Total	100	87.76	88.38	92.94	92.44	88.81	5.853 N.S.
Sensory evaluation of cake							
Treatments	**Degree**	**WK0**	**CK1**	**CK2**	**CK3**	**CK4**	**L.S.D.**
Symmetry of form	10	7.00	8.13	8.00	8.50	8.25	1.63 NS
Crust Color	10	8.73^{b}	8.71^{b}	10.00^{a}	9.31^{ab}	8.84^{b}	1.07 *
Softness	10	8.00	8.50	7.88	7.75	7.50	0.782 NS
Section Homogeneity	10	7.38	8.00	8.13	7.75	7.63	0.861 NS
Moistness	10	8.13	8.38	8.38	8.00	8.38	0.512 NS
Crumb Texture	10	7.25^{b}	8.50^{a}	7.75^{ab}	7.25^{b}	6.88^{b}	1.14 *
Crumb Color	10	10.00^{a}	7.54^{b}	6.24b^{c}	5.30^{c}	4.96^{c}	1.33 *
Aroma and Taste	20	16.63^{a}	15.88a^{b}	13.38^{b}	13.88^{b}	14.00^{b}	2.067 *
Acceptability	10	7.88a^{b}	8.75^{a}	8.50^{a}	7.13^{b}	7.50^{b}	1.19 *
Total	100	80.98^{a}	82.38^{a}	78.24^{ab}	74.86^{b}	73.93^{b}	5.73 *
.(P≤0.05) *							

WB0: (Control biscuit treatment) consisting of the basic ingredients. CB1, CB2 and CB3 and CB4 are basic ingredients with 1%, 2%, 3% and 4% substitution of wheat flour by carrot green parts powder respectively. WK0: (Control cupcake treatment) consisting of the basic ingredients. CK1, CK2, CK and CK4 basic ingredients with 1%, 2%, 3% and 4% substitution of wheat flour by carrot green parts powder respectively.

Hlaváčová et al. (22) observed significant variations in taste profiles among different vegetable additives used in biscuits. For instance, reviewers reported a distinct "grassy taste" in biscuits containing 3% nettle powder, while another reviewer described a pleasant combination of spice and fruity aroma in biscuits with the same amount of nettle powder. Overall, the biscuit with 3% carrot powder were the best due to their constant attributes and very satisfactory aroma. Additionally, they said that the sensory characteristics of enriched biscuits play a crucial role in enhancing the consumer's perception and acceptance of high-quality items. To establish the appropriate quantity of additives in the product, it is necessary to consider its favorable nutritional content.

Table 5 shows the sensory evaluation scores for the cake parameters under study. It is clear from the table that there were no significant differences in the characteristics of the external shape's regularity, the crumb texture's smoothness, and the section's homogeneity (graininess and tenderness). The treatments CK2 and CK3 achieved the highest degrees of crust color, with a significant difference ($P \leq 0.05$) than the rest. Adding the carrot green parts powder in treatments CK2 and CK1 improved the consistency of the crumb and made it softer, with significant differences compared to the rest. Increasing the replacing ratio (K4 and K4) showed negative effect on the crumb characteristics, making it rougher and harder. Treatment WK0 achieved the highest scores in the characteristics of crumb color aroma and taste, then decreased with increasing the proportion of added vegetable parts powder. Finally, treatments WK0, CK1, and CK2 obtained the highest general acceptance score, which reflected on the total sensory evaluation scores. The CK3 and CK4 treatments differed significantly in comparison to WK0 and were largely acceptable. The color of the crumb may be affected by increasing the replacement ratio due to the high percentage of ash and colored chemical compounds that are involved in the formation of color reactions, in addition to reducing the effect of sucrose in giving the desired color and taste to the baked product (21; 8; 35). The results of this study agreed with what was indicated by (32) and (41) that cake pieces became harder with increasing the replacing ratio, as the hardness of the cake is directly related to the density of the tested materials. The size of the cake, the consistency of the cake mix viscosity and the amount of aeration determine the internal resistance of the food structure. Replacing wheat flour by different ratio (1, 2, 3, and 4%) of carrot green parts powder in manufacturing biscuit and cake enhanced the nutritional value by increasing their content of ash, crude fiber, and protein. In addition to improving the sensory characteristics of the final product. The including of higher concentrations of powdered green parts resulted in high public's receptiveness towards these products. This confirms the incorporation of these concentrations in the production of biscuits and other baked goods, given their widespread consumption and the advantageous therapeutic effects they offer, along with their positive impact on the job market. They have been used for several generations. Various civilizations use medicinal plants to address a wide range of disorders that afflict humanity. In recent years, there has been a renewed emphasis on studying medicinal plants and finding ways to effectively handle industrial and agricultural waste. These areas of research are important because they provide valuable, non-toxic, affordable, and readily available natural resources.

REFERENCES:

1. Al-Khafaji, A. M. H. H. and K. D. H. Al-jubouri. 2024. Developmental control of some physiological factors on reproductive biology and rudimentary embryos phenomenon in carrot seeds. Iraqi Journal of Agricultural Sciences, 55(3):1038-1047. https://doi.org/10.36103/zvrre033

2. Abdo, E. M.; O. E. S. Shaltout; S. El-Sohaimy; A. E. Abdalla and A. M. Zeitoun. 2021. Effect of functional beetroot pomace biscuit on phenylhydrazine induced anemia in albino rats: Hematological and blood biochemical analysis. Journal of Functional Foods, 78, 104385. https://doi.org/10.1016/j.jff.2021.104385.

3. Ahmad, T.; M. Cawood; Q. Iqbal; A. Ariño; A. Batool; R. M. S. Tariq, R. M. S Tariq and S. Akhtar. 2019. Phytochemicals in *Daucus carota* and their health benefits. Foods, 8, 424 https://doi.org/10.3390/foods8090424.

4. Al-badri R. H. 2012. Extraction, Partial Purification and Characterization of Peroxidase from *Malva neglecta* A Thesis Submitted to the College of Science-University of Baghdad as a Partial Fulfillment of the Requirements for the Degree of Master of Science in Biotechnology.

5. Albandary, N. A. 2023. Phenolic compounds content, antioxidant, antibacterial and antifungal activities of red onions skin. Iraqi Journal of Agricultural Sciences, 54(4), 1050-1057, https://doi.org/10.36103/ijas.v54i4.1794

6. Aljelawi, H. J. R. 2017. Using transglutaminase in improving local wheat *(Al-rasheed Variety)* bread quality. A Thesis of

Master of Science in Food Science. In The Department of Food Science. Collage of Agriculture. Baghdad University.Iraq.78-86.

7. AL-Kharkhi M. H. S. H. 2020. Enrichment of bread Flour by Rashid germinated wheat cultivar and studying its functional properties. A thesis submitted to the Council of the college of Agriculture Engineering Sciences-University of Baghdad in partial fulfilment of the requirements for the degree of Master in Agriculture Engineering Sciences /Food Science.

8. Al-Mhyawi, E. K., and J. M. Nasser. 2023. August. physical and functional properties of some millet cultivars in Iraq. In IOP Conference Series: Earth and Environmental Science 1225(1): 012036

9. Al-Muhayawy, E. K. H. 2018. Use of the Wheat Phytase Enzyme To Reduce The Level Of Phytates In Bread And Biscuits Made From Whole Wheat Flour. M.sc. thesis, college of agricultural engineering sciences, university of Baghdad. pp:54-112.

10. Approved Method of American Association of Cereal Chemists, A.A.C.C. 2002. Approved Methods of A.A.C.C. Published by the American Association of Cereal Chemists. 13th.Edition, St. Paul, Inc.

11. Approved Methods of the American Association of Cereal Chemists, AACC. 2000. Vol. (1) St. Paul, Minnesota, USA.

12. Approved Methods of the American Association of Cereal Chemists, AACC. 2010. St. Paul, Minnesota, USA.

13. Asadi, S. Z. and M. A Khan, 2023. Development and organoleptic evaluation of biscuits with added dietary fiber from vegetables and fruits. journal of culinary Science & Technology, 1–13. https://doi.org/10.1080/15428052.2023218125 2.

14. Baixauli R., T. Sanz, A. Salvador, and S.M. Fiszman. 2008. Muffins with resistant starch: Baking performance in relation to the rheological properties of the batter. Journal of Cereal Science, 47(3): 502-509. https://doi.org/10.1016/j.jcs.2007.06.015.

15. Ceylan, F. and E. Yücel. 2015. Consumption forms and nutrient content values of wild Plants Consumed as a Food in and around Düzce. Düzce. AKU J. Sci. Eng. 15: 1-17. https://doi.org/10.5578/fmbd.10227.

16. Dipesh A.; L. Sabikhi, M.H.S. Kumar, and N. R. Panjagari. 2018 .Investigating the effect of resistant starch, polydextrose and biscuit improver on the textural and sensory characteristics of dairymultigrain composite biscuits using response surface methodology. Journal of Food Measurement and Characterization, 12(6):1167-1176. https:// "doi." org/10.1007/s11694-018-9730-7.

17. Dos Santos, A. C.; N. N. Yassunaka; S. P. Ruiz; V. V. A. Schneider; J. V. Visentainer, J. V., and G. S. Madrona. 2013. Sensory and physicochemical study of carrot leaf sponge cake. Braz. J. Food Res, 4: 41-46 DOI: http://dx.doi.org/10.14685/rebrapa.v4i2121

18. Ergun, M., and Z. Süslüoğlu. 2018. Evaluating carrot as a functional food. Middle East Journal of Science, 4(2), 113-119 https://doi.org/10.23884/mejs.2018.4.2.07.

19. Fakhfakh, N.; H. Jdir; M. Jridi; M. Rateb; L. Belbahri; M. A. Ayadi and N. Zouari. 2017. The mallow, Malva aegyptiaca L.(Malvaceae): Phytochemistry analysis and effects on wheat dough performance and bread quality. LWT, 75, 656-662. http://dx.doi.org/10.1016/j.lwt.2016.10.015

20. Goneim, G. A. , F. Y. Ibrahim and Sh. M. El-Shehawy. 2011. Carrot leaves:antioxidative and nutritive values . Journal of Food and Dairy Sciences, 2(4), 201-211 DOI: 10.21608/JFDS.2011.81946.

21. Hammoud, E. K., and A. C. Saddam. 2024. Improving nutritional and qualitative properties of wheat bread by using mallow (*Malva neglecta* L.) leaves powder. Iraqi Journal of Agricultural Sciences, 55(1), 560-568 https://doi.org/10.36103/8p73pr77

22. Hlaváčová, Z.; E. Ivanišová; L. Harangozo; A. Petrović; D. Kušteková; B. Gálik & V. Vozárová. 2021. Physico-chemical and sensory profiles of enriched linz biscuits. Foods, 10(4), 771 https://doi.org/10.3390/foods10040771.

23. Hind,K.A. ,J.M.Nasser, and K.A.Shaker. 2022. Extraction, Purification and charactwrization of lipase from the digestive duct of common carp *cyprinus carpio* L . Iraqi Journal of Agricultural Sciences , 53(5): 1011–1020. doi:10.36103/ijas.v53i5.1615

24. Jassim Al-khafagi, M. F., and D. Y. Mohammed. 2023. Comparison phytochemical compounds from two different solvents of

crude capparis spinosa extracts. Iraqi Journal of Agricultural Sciences, 54(5), 1234-1242. https://doi.org/10.36103/ijas.v54i5.1818

25. Kamel, D. G.; A. R. Hammam; M. A. N. El-Diin; N. Awasti & A. M. Abdel-Rahman. 2023. Nutritional, antioxidant, and antimicrobial assessment of carrot powder and its application as a functional ingredient in probiotic soft cheese. Journal of Dairy Science, 106(3), 1672-1686. https://doi.org/10.3168/jds.2022-22090.

26. Kausar, H.; S. Parveen; M. M. Aziz & S. Saeed. 2018. Production of carrot pomace powder and its utilization in development of wheat flour cookies. Journal of Agricultural Research (03681157), 56(1).

27. Kazim, E. H.; J. M. Nasser and E. A. Saleh. 2012. The effect of adding *Nigella sativa* to some baked products. University of Karbala, Second Scientific Conference of the College of Agriculture. 1117-1118.

28. Kibar, B., & S. Temel. 2016. Evaluation of mineral composition of some wild edible plants growıng in the eastern Anatolia Region Grasslands of Turkey and consumed as vegetable. J. Food Process. Preserv., 40(1), 56-66; DOI:10.1111/jfpp.12583.

29. Kolawole, F. L.; M. A. Balogun; D. O. Opaleke & H. E. Amali. 2013. An evaluation of nutritional and sensory qualities of wheat-moringa cake. Agrosearch, 13(1), 87-94;DOI: 10.4314/agrosh.v13i1.9.

30. Leite, C. W.; M. Boroski. J. S. Boeing; A. C. Aguiar; P. B. França; N. E. D. Souza & J. V. Visentainer. 2011. Chemical characterization of leaves of organically grown carrot *Dacus carota L.)* in various stages of development for use as food. Food Science and Technology, 31(3), 735-738 10.1590/S0101-20612011000300028.

31. Li, Y.; S. Jiang; Y. Zhu; W. Shi; Y. Zhang & Y. Liu. 2023. Effect of different drying methods on the taste and volatile compounds, sensory characteristics of Takifugu obscurus. Food Science and Human Wellness, 12(1), 223-232. https : / / doi . org / 10. 1016 / j. fshw. 2022 .07.012.

32. Lu, T. M.; C. C. Lee; J. L. Mau & S. D. Lin. 2010. Quality and antioxidant property of green tea sponge cake. Food Chemistry, 119(3), 1090-1095. DOI:10.1016/j.foodchem.2009.08.015.

33. Mousa, M. A.; N. T. Khalid and E. K. Hamood. 2019. Reduction of acrylamide content of bread by some herbs and plants. Biochem. Cell. Arch, 19(2), 2819-2822. 10.35124/bca.2019.19.2.2819.

34. Nashmi, R. J., and J. M. Naser. 2022. Improving the rheological and qualitative properties of bread wheat by barley-extracted pentosanes. Iraqi Journal of Agricultural Sciences, 53(5), 1212-1222. https://doi.org/10.36103/ijas.v53i5.1635.

35. Nasser, J. M., and E. K. Hammood. 2020. Effect of flour type on phytic acid degradation during biscuit making. Plant Archives 20(1):pp(325-330).

36. Niaba-Koffi, P. V.; G. Gildas; A. G. Beugre and D. Gnakri. 2013. Nutritional and sensory qualities of wheat biscuits fortified with defatted Macrotermes subhyalinus. International Journal of Chemical Science and Technology, 3(1), pp(25-32).

37. Özer, M..O and M. Aksoy. 2019. Mineral composition and nutritional properties of *Malvaneglecta* and *Malvellasherardiana* consumed as vegetable in Central Black Sea Region of Turkey. Turkish Journal of Food and Agriculture Sciences.1(1): pp (18-23).

38. Paul D. 2016. A review on biological activities of common mallow *(MALVA SYLVESTRIS L.).* Vol 4, Issue 5, 2016 ISSN - 2321-550X; http://orcid.org/0000-0002-5664-4601

39. Peluola-Adeyemi, O. A; R. B. Abdus-Salaam & T. Obi. 2021. Quality Evaluation of Bread Produced from Wheat Flour using Avocado (Persea americana) Paste as Substitute.4 (1), 1-12 DOI: 10.36400/J.Food.Stab.4.1.2021-0041.

40. Požrl, T., Kopjar, M., Kurent, I., Hribar, J., Janeš, A. and Simčič, M., 2009. Phytate degradation during breadmaking: the influence of flour type and breadmaking procedures. Czech Journal Of Food Sciences, 27(1), pp.29-38.

41. Salehi, F. and S. Aghajanzadeh. 2020. Effect of dried fruits and vegetables powder on cakes quality: A review. Trends in Food Science & Technology, 95, 162-172. https: // doi. org/ 10 . 1016/j.tifs.2019.11.011.

42. SAS. 2012. Statistical Analysis System, User's Guide. Statistical. Version 9.1th ed. SAS. Inst. Inc. Cary. N.C. USA.

43. Sara, H., M. Majzoobi, and A. Farahnaky. 2018. Batter rheology and quality of sponge cake enriched with high percentage of resistant starch (Hi-maize). International Journal of Food Engineering, 14(6-5), 20170293. https://doi.org/10.1515/ijfe-2017-0293.

44. Sharma, K. D.; S. R. Karki; N. S. Thakur and S. Attri. 2012. Chemical composition, functional properties and processing of carrot—a review. Journal of Food Science And Technology, 49(1), 22-32. DOI:10.1007/s13197-011-0310-7.

45. Sheng Xiong, Que, Feng, Xi-Lin Hou, Guang-Long Wang, Zhi-Sheng Xu, Guo-Fei Tan, Tong Li, Ya-Hui Wang, and Ahmed Khadr, and. 2019. Advances in research on the carrot, an important root vegetable in the Apiaceae family. Horticulture research, 6.

46. SY, B. 2014. Effect of incorporation of carrot pomace powder and germinated chickpea flour on the quality characteristics of biscuits . International Food Research Journal, *21*(1)., pp 217-222.

47. Tabaraki M. R.; Z. Yosefi; and H. A. A. Gharneh. 2012. Chemical Composition and Antioxidant Properties of Malvasylvestris L.Journal of Research in Agricultural Science.Vol. 8, No. 1 (2012), : 59 – 68

48. Utta, D. P.; V. E. Pradesh and T. K. Singh. 2015. Chemical composition of finger millet of food and nutritional security. International Scholars Journals Food Sciences Microbial, 5(8),pp.001-008.

49. Yegin, S.; A. Kopec; D. D. Kitts and J. Zawistowski. 2020. Dietary fiber: A functional food ingredient with physiological benefits. In Dietary sugar, salt and fat in human health (pp. 531-555). Academic Press. https://doi.org/10.1016/B978-0-12-816918-6.00024-X.

50. Zouari, N.; N. Fakhfakh; S. Zouari; M. Sellami; M. Abid; and M. A. Ayadi. 2011. Volatile and lipid analyses by gas chromatography/mass spectrometry and nutraceutical potential of edible wild Malvaaegyptiaca L. (Malvaceae). Int J Food SciNutr 62(6), 600–608. DOI:10.3109/09637486.2011.564157