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ORIGINAL ARTICLE

Effect of replacing wheat flour with red carrot powder on the physicochemical and sensory properties of cake

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Abstract

The study aimed to produce cake by replacing wheat flour with red carrot powder by 0, 15, 20, and 25% and studying its effect on physicochemical and sensory properties. The chemical estimates showed that the moisture content decreased as the replacement percentage increase compared to the control sample. The protein, fat, and ash percentage increased with increasing percentages of red carrot powder. A study of some physical characteristics of the treatments with different ratios of substitution showed that the higher the substitution ratios for red carrot powder, the greater the weight and volume of the cake product. In contrast, the specific volume of the cake was the highest value for the cake without red carrot powder added. As for the height of the cake, it was the highest value at the replacement ratios of 20 and 25%, represented by treatment T2 and T3, respectively, compared to the control sample. The sensory evaluation of the cake product showed that the color characteristic recorded the highest value in treatment T1. The odor recipe was distinguished upon treatment T2 and T3. The taste characteristic of the cake product differed significantly from the rest of the treatments T0 and T1, and the texture recipe recorded the highest value on transaction T3. The results of the pH values indicated a gradual decrease in the pH values during storage for all treatments of the cake product, compared to the control sample, and the occurrence of damage and spoilage of the product after 30 days. The results of the water activity values of the cake models manufactured for different proportions during different storage periods 1, 10, 20, and 30 days showed a gradual decrease with the increase of time.

1. Introduction

Bakery products are widely consumed worldwide, becoming a significant food item. Cake is one of the most common bakery products people consume nowadays [1]. The cake is mainly known as the semi-dry foam resulting from solidifying the liquid medium inflated by gases resulting from the interaction of chemicals, expanding air, or water vapor formed. The cake is made from flour, sugar, and eggs; these ingredients are mixed to make a snack, as it has become a favorite food worldwide. The cake is usually sold without loose packaging and is stored at room temperature for 1-2 days, depending on the temperature and humidity [2]. Used in the preparation of the dough, the nature of their interactions and the air included in the dough and manufacturing conditions in the cake quality [3]. Red carrots have been widely studied due to their nutritional properties that confer important and distinct properties as red carrots play an essential role in human nutrition because they contain a variety of health-promoting components [4], including antioxidants and some vitamins

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such as vitamin (E, C) it also contains phenolic acids including hydroxy cinnamates and caffeic acid, which contribute significantly as antioxidants in addition to its high content of anthocyanins. Red carrots have been used in making juices, jams, pickles, bread, cakes, and functional drinks [5]. Red carrots are also very rich in fiber, which helps improve the absorption of nutrients in the gastrointestinal tract, helps regulate bowel movement, and lowers cholesterol levels. Dietary fiber also regulates insulin and glucose secretion in the body, making it an excellent choice for diabetics [6]. Red carrot powder contains 51.6% cellulose, 32.2% high amounts of lignin, 3.88% pectin, and 12.3% hemicellulose. This study aimed to manufacture cake fortified with functional food with different ratios of replacement of red carrot powder, study its chemical properties, and identify the sensory characteristics of the food product.

2. Materials and Methods

Preparation of red carrot powder: Red carrots were obtained from the local markets of Tikrit, after which they were washed with tap water, cut into small pieces, and spread on aluminum foil for drying. Usage: In the study, wheat flour was used (extraction rate 72%) of Kuwaiti origin available in the local market produced by the Kuwaiti company (Al-Fakher), in addition to the use of other ingredients, namely sugar, fat, salt, vanilla, milk powder, fresh eggs, and baking powder [7].

2.1 Preparation of mixtures

Wheat flour was mixed with red carrot powder as follows, and the mixtures were in different proportions.
The cake was made from the following ingredients
100 gm of flour (according to the proportions of red carrot powder replacement), 30 gm of sugar, 15 gm of fat, 1 gm of baking powder, 0.5 gm of milk powder, 24 gm of eggs, 0.5 gm of salt, changed water. The cake was prepared according to what was mentioned by [8] by mixing sugar and fat together until it became creamy, then adding eggs and vanilla while continuing to mix, then adding the well-mixed dry ingredients (flour, powdered milk, salt and baking powder) and mixing well for one minute, then the dough was formed with cake moulds. 6 cm in diameter, then baked in an oven at a temperature of 175 C for 10 minutes, then the cake pieces were removed from the oven, cooled in the room atmosphere, and the samples were stored until laboratory tests were performed.

Table 1: Different proportion of wheat flour and red carrot powder

Replacement ratios %	Wheat flour weight (g)	Weight of red carrot powder (g)
0	100	0
15	85	15
20	80	20
25	75	25

2.2 Chemical tests

The chemical tests were measured for the samples of wheat flour, red carrot powder and cake produced, as moisture, protein, fat, ash and carbohydrates were estimated.

2.3 Determination of humidity

5 gm was weighed and placed in a special container in [9]. The percentage of humidity was estimated according to what was stated in an electric oven at a temperature of 105 °C until the weight was stable. The following equation was applied: percentage of moisture = (sample weight_ sample weight after drying/ sample weight) × 100.

2.4 Estimation of protein content

The protein percentage was estimated using the standard Kildall method and using the Kildall device by taking 0.2 g of raw material. The protein percentage was extracted by multiplying the percentage of nitrogen in the sample by the protein coefficient of 6.25 [10].

2.5 Estimation of fat percentage

The fat was measured according to the [10] method, by the intermittent extraction method in the soxhlet device, with a weight of 3 g of the raw material sample, and the use of petroleum ether solvent with a boiling point of 70 m ^{o} in the extraction process that took 5 hours, after which the solvent was removed using a rotary evaporator to obtain fat and calculate its percentage by adopting the following equation:

$$Fat\% = \frac{Fat\ weight}{sample\ weight} \times 100$$

2.6 Estimation of ash content

The ash percentage was estimated according to the method used [11], and 2 g of samples were taken and placed in a ceramic lid, then dried using an electric oven at a temperature of 100 C to get rid of moisture, then the lid was transferred to an incineration oven at a temperature of 600 C until stability Weight and obtain a white or gray powder and the percentage of ash was calculated through the following equation:

$$Ash\ percentage\ \% = \frac{Ash\ weight\ with\ lid\ (gm)\_\ empty\ lid\ (g)}{sample\ weight\ (g)} \times 100$$

The percentage of total carbohydrates was estimated using the arithmetic difference method, according to what was mentioned in [12].
And as follows: carbohydrates% = 100 _ (moisture + ash + protein + fat). The physical properties of the cake product were determined from height and volume measurement (cm^3) by seed displacement method, weight and extraction of specific volume (cm^3 / g) by dividing the cake volume by its weight by

[13]. The sensory evaluation of the cake product was conducted in the laboratory of the College of Agriculture/University of Tikrit by thirteen teachers and students of the Department of Food Sciences, according to the evaluation form shown in Tabler 2. Scores were distributed according to mentioned [14].

Table 2: Cake product sensory evaluation form

Sequencing	Transaction	Color 20	Smell 20	Taste 30	Strength 30
1	T0	-	-	-	-
2	T1	-	-	-	-
3	T2	-	-	-	-
4	T3	-	-	-	-

25% substitution. T3: 20% substitution, T2: 15% substitution, T1 Control sample: T0

2.7 Cake preservation

After letting the cake cool for 60 minutes, store in polypropylene bags and keep at room temperature 25 C for 30 days. From the tests that were carried out on the cake product and for percentages of 0, 15, 20 and 25% after storage at room temperature for 30 days, which is to estimate the pH and water activity.

2.8 Determination of pH (PH)

The pH values of the stored cake product were estimated according to the method described [15] , by weighing 5 g of each percentage of the cake product and adding 50 ml of distilled water to it and mixing well, then the pH was measured using an electronic pH meter (PH meter). The water activity was estimated using the (Axier L td Novasina instrument, according to [16].

The experiment was carried out (CRD), Randomized Design Complete, and the experiment was implemented according to the complete random design within the statistical program (General Linear Model). The different averages are at a probability level of 0.05 [17].

3. Results and discussion

3.1 Chemical tests for the samples used in the study

Table 3 showed the values of the chemical composition of the flour sample used in the study, as the moisture content is important from the manufacturing point of view for the cake, which greatly affects the storage period of the cake because it directly affects the amount of microorganisms present in the manufactured product, and the amount of moisture for wheat flour was 11.23% As for protein, it is an important factor in determining the quality of the resulting cake, as flour with a high protein content gives a product of good quality. From Table 3, it is noted that the percentage of protein amounted to 9.50%, and fat is an important indicator for predicting the size of the cake, and fat is associated with protein to form Complexes working on the formation of the gluten network, the percentage of fat was 2.01%, as can be seen from the same table, the percentage of ash and carbohydrates, which amounted to 1.95, 75.31%, respectively. These results were identical to what [18] stated, as he indicated that whole wheat is a source of carbohydrates, amounting to 75.31% and protein 9.53%, while the percentage of moisture and ash fat reached 11.54, 2.61, and 1.03%, respectively. The same table also shows the chemical analysis values of red carrot powder used in the study, as the moisture content of red carrot powder was 10.21%, while the protein percentage was 4.36%, and the remaining components were 1.87, 5.09, 78.47% for fat, ash and carbohydrates, respectively. This study was consistent with what was stated by [19], as they indicated that the moisture percentage was 10.14%, while the protein percentage was 4.86%, while the percentage of fat, ash and carbohydrates was 1.40, 5.89, and 75.8%, respectively. [20] also mentioned that the percentage of moisture in red carrot powder was 6.06%, while the percentage of protein, fat and ash was 8.82, 1.60, and 5.65%, respectively.

Table 3: Chemical composition of the samples used in the study

Transactions	Humidity %	Protein%	Fat %	Ash %	Carbohydrate %
Wheat flour	11.23	9.50	2.01	1.95	75.31
Red carrot powder	10.21	4.36	1.87	5.09	78.47

3.2 Chemical composition of different cake treats

The effect of replacing wheat flour with red carrot powder for different cake treatments. Table 4 showed the effect of replacing wheat flour with red carrot powder on the chemical composition of cake for different treatments and for the studied characteristics. A value of 3.71%, with a difference from the replacement rates of 15, 20, and 25%, as the values amounted to 2.76, 2.33, and 2.50%, respectively. The reason for this may be due to the lack of amino acids in the red carrot powder that have the ability to absorb water. As for the protein content, it increased with the increase in the replacement rate, as the highest value for protein was at the 25% replacement rate, which amounted to 15.80%, compared to the control sample, which amounted to 7.50%. This indicates a higher protein content in the red carrot powder compared to wheat flour. The replacement rate was 25%, reaching 10.76% compared to the control sample, which was 6.62%, and then the replacement rates were 15 and 20%, which amounted to 9.25 and 10.17%, respectively. The difference in the percentage of fat between the control treatment and the replacement treatments may be due to the chemical composition of the red carrot powder [21]. As for the ashes, it increased with the increase in the replacement rates for red carrot powder, reaching 3.15, 3.20, 3.41% for the replacement rates of 15, 20, and 25%, respectively, compared to the control sample, which amounted to 1.48%. As for carbohydrates, it amounted to 43.12, 70.18, and 67.53% for the replacement rates. 15, 20, and 25%, respectively, compared to the control sample, which amounted

to 60.21%. This result was identical to what was stated by [22] , who indicated that fortifying the cake by 5, 10, 15, 20% of soybean flour leads to an increase in protein, fat, and ash, and a decrease in moisture and carbohydrates. [23] also indicated an increase in the chemical composition of the cake product, especially in protein, when the substitution ratios increased. These results also agree with what was indicated by [24] , which indicated a gradual increase in the level of protein and ash and a decrease in the moisture content by increasing the substitution rates for red carrot powder for the cake product.

Table 4: Effect of replacing wheat flour with red carrot powder on the chemical composition of different cake treatments

Transactions / Chemical Composition	Humidity %	protein %	fat %	Ash %	Carbohy-drate%
T0	3.71	7.50	6.62	1.48	60.21
T1	2.76	13.60	9.25	3.15	43.12
T2	2.33	14.25	10.17	3.20	70.18
T3	2.50	15.80	10.76	3.41	67.53

T0 = control sample, T1= red carrot powder replacement ratio 15%, T2= Replacement ratio of red carrot powder 20% , T3= Replacement ratio of red carrot powder 25%.

3.3 The effect of substitution on the physical properties of cake

Table 5 showed the effect of substitution on the physical properties of the cake made from red carrot powder. The largest weight of the cake product was at 20 and 25% replacement ratios for red carrot powder, which amounted to 45.67 and 50.61 g, respectively, compared to the control sample, which was 41.21 g. The volume of the cake recorded the highest value at the replacement rates of 20, 25%, which amounted to 123.07 and 130.10 cm^3, respectively. It was found that the higher the replacement rates for red carrot powder, the greater the weight and volume of the cake product. Anise and black seed in the qualitative properties of laboratory shortening cake. While the specific volume (fluffiness) was the highest value for cake without red carrot powder added 2.52 (cm^3/g), while the specific volume was 2.50, 2.31, 2.16 (cm^3/g), respectively, for cake with red carrot powder added at a ratio of 15, 20 , 25%, and this was identical to what [25] found, as he showed that the specific size of the cake decreased when adding different percentages 0.5, 1.0, 1.5% of the sweet bean powder, while there was no difference between treatment T0, T1, and treatment T3. It had the lowest value, and this is due to the effect of red carrot powder, which works to weaken the gluten network, which is responsible for seizing gas bubbles in baked products. [26] indicated that there is a linear relationship between the replacement ratios, weight and density, as the higher the replacement ratios for red carrot powder, the greater the weight and density of the cake product. The reason for this increase may be attributed to the presence of dietary fiber in red carrot powder, which leads to an increase in the ability to retain water. Table 5 showed that the highest height of the cake was at the replacement ratios of 20 and 25%, represented by treatment T2 and T3, which were 7.81 and 8.95 cm, respectively, compared to the control sample, which was 6.01 cm. It was found that calculating the height of the cake product indicates an important characteristic. To know the quality and sensory properties such as texture and texture [27].

Table 5: Effect of substitution on the physical properties of the cake

Physical Property / Transactions	Weight (g)	Size V (cm^3)	W/V*10 Specific Volume (cm^3/g)	height (cm)
T0	41.21	111.02	2.52	6.01
T1	43.52	115.67	2.50	7.34
T2	45.67	123.07	2.31	7.81
T3	50.61	130.10	2.16	8.95

T0: control sample, T1: 15% substitution of red carrot powder, T2: 20% substitution of red carrot powder, T3: 25% substitution of red carrot powder

3.4 Effect of replacing red carrot powder with different ratios on sensory evaluation of processed cake

Table 6 showed the effect of replacing red carrot powder on the sensory evaluation of the manufactured cake, as it is noted from the table that the color characteristic recorded the highest value at 15% replacement rates represented by T1 treatment of 18 compared to the control sample 17, as it was significantly superior to replacement rates 20, 25 % represented by the treatment T2, T3, which amounted to 17, 17, respectively. As for the smell characteristic, the replacement rates were 20, 25% represented by the treatment T2, T3, which amounted to 19, 19, respectively. The taste characteristic was distinguished at the replacement rates of 20, 25% represented by the treatment. T2 and T3 of 28 and 28, respectively. It differed significantly from the rest of the treatments T0, T1, as it reached 26, 27, respectively. As for the character of stature, it was found that the highest value was recorded at the replacement rate of 25%, represented by treatment T3, which amounted to 29, and differed significantly in the rest of the treatments T0, T1, and T2, amounting to 27, 26, and 27, respectively.

Table 6: Effect of replacing red carrot powder in different proportions on the sensory evaluation of the processed cake

Sensory quality / Transactions	Color	Odor	Taste	Texture
T0	17d	18d	26d	27d
T1	18b	18b	27a	26b
T2	17a	19a	28b	27a
T3	17a	19a	28b	29a

The reason for the high evaluation scores in the sensory characteristics of the cake by adding concentrations of red carrot powder may be attributed to its possession of a number of functional and nutritional properties that may enhance the quality of the cake product, as soluble fiber increases the ability to bind water, which positively affects improving the texture of the resulting cake [28]. These results were consistent

with the results obtained by [29], as they indicated that increasing the proportion of red carrot powder improves the sensory qualities and nutritional value of the cake product.

3.5 Changes in pH values during storage

Table 7 showed the obtained pH values for cake samples in different proportions during the 30-day storage period. 10, 20, respectively, and damage and spoilage of the product occurred after 30 days. The decrease in pH during the storage period can be explained by the increase in the activity of microorganisms [30], and these results are consistent with the findings of [31,32] also indicated that the pH values of the cake decreased as the replacement percentages for red carrot powder increased.

Table 7: Changes in the pH values of cake samples during the storage period

Transactions	Storage period (day)			
	1	10	20	30
T0	6.67	6.52	6.34	SP
T1	6.45	6.20	5.78	SP
T2	6.63	6.60	6.57	6.46
T3	6.65	6.57	6.32	6.01

SP: Spoilage sample

3.6 Changes in water activity values during storage

Table 8 showed the values of water activity for cake models manufactured for different proportions and their effect during different storage periods 1, 10, 20, 30 days, as the results showed a gradual decrease with the increase of time and this decrease focused on cake models for all treatments at a storage period of 20, 30 days, while there was no clear change in the water activity values of the cake samples manufactured at the storage period of 1 and 10 days. It is clear from the foregoing that the decrease in the water activity values of the cake models during the storage period may be due to the migration of moisture from the pulp to the surface of the cake [33] and the reason for the permeability of the coating [34].

Table 8: Changes in the water activity values of cake samples during the storage period

Transactions	storage period (day)			
	1	10	20	30
T0	0.81	0.80	0.77	SP
T1	0.81	0.79	0.76	SP
T2	0.83	0.78	0.75	0.73
T3	0.82	0.79	0.77	0.74

SP: Spoilage sample

The water activity test is very important, as it is useful in knowing the extent of food safety and stability during its shelf life and storage, as the different ingredients in the cake compete with each other in order to bind with water for dissolution and hydration, for example, sugars and salts when melted reduces pressure Steam and the availability of water for whatever microorganism is present in the food product, and thus the water activity decreases and the shelf life increases by increasing the concentration of these substances[35].

4. Conclusions

The possibility of using red carrot flour as a substitute for wheat flour with different replacement ratios. Cake production acceptable to consumers**.** Producing a functional cake that contains an amount of protein and carbohydrates**.** The possibility of preserving and storing the produced cake for periods of time and under normal storage conditions.

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