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Effect of using Non-dairy creamer as a fat substitution on quality properties of cake

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Abstract

The present study aimed to study the effect of using a non-dairy creamer (NDC) by partial substitution levels 10, 15 and 20% of fat on quality properties of cake. The results reveal that NDC contains 1.93, 34.15 and 5.5 protein, lipid and ash (on dry basis), respectively. On the other hand, moisture, protein, ash, fibers, carbohydrates, volume and particular volume in cake treatments were increased with increased of substitution level of NDC, while, the lipids and hardness was decreased with increased the substitution level of NDC in comparison with control sample. The crust and crumb color of cake treatments which contain different level of NDC were light in the color than control sample. Sensorial evaluation stated that no significant influence was noticed between cake treatments containing different levels (10, 15 and 20%) of NDC and control sample. Finally, substitution of fat by different levels of NDC led to improvement the quality characteristics of the cake and produced low fat cake with keeping good physiochemical and sensory properties.

Keywords Non-dairy creamer, fat replacer, cake, fat substitution.

1. Introduction

Production of imitated dairy products is new industries in dairy industries. Imitated dairy products domain from complete dairy alternatives, with no dairy ingredients, like soy milk, to products that have a rise proportion of dairy ingredients, which contain some non-dairy constituent. These products are entreaty to manufacturers and consumers in terms of economical and nutritional features, hence, it should be noticed the imitation dairy products should be resembling in terms of apparent, sensory and textural properties as much as possible to dairy product [1] [2].

Non-dairy creamer "vegetable milks or vegetable creamer" is widely enter in food industry, like flour products, candy, chocolate, and drinks. The type of product has been agreeable gently by consumers for sundry reasons, economic, good antioxidant capacity, being ease of solubility in water, ease of handling and improved shelf life [3].

Functionally, non-dairy creamer has many advantages over with dairy products in general, so this product is considered as a substitute for creamer made from milk, evaporated milk, or fresh milk. Ingredients Non-dairy creamer raw materials use vegetable oil as a source of fat. One of the advantages of vegetable fat is that it does not contain lactose, so the use of vegetable fats in non-dairy creamer products is very safe, especially for people with lactose intolerance. Besides that, non-dairy creamer also has advantages including long shelf life and ease of storage, distribution and handling. Non-dairy creamer is also known as artificial creamer which is made based on the constituent ingredients in the form of vegetable oil, proteins, stabilizers and emulsifiers which are combined into a solution and then dried by spray drying [4]. Non-dairy creamer is a kind of microencapsulated oil powdered products extracted from oil [3]. Vegetable creamers have been used in different products as dispersing assistant, flavor carrier, bulking agent, thickener and fat replacer [5] [6]. Cereal products, produced mainly from wheat and maize flour, are the major fortified food to increase its nutritional value and sensory characteristics [7] [8]. Bakery products are well agreeable worldwide due to of the low cost, ease of Preparation, variation, sensory properties and nutritional attributes. Cake is product that has the highest consuming average among baked goods [9]. Cake quality is mightily dependent on the kind of ingredients, formulation and baking conditions. A good-quality cake must be altitude volume with a fine uniform wet crumb [10]. Among baked goods, cakes have high consumption rates as

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compared to the other products [11]. Baked goods represents the main diet component which provide important source of carbohydrate and fat [12] [13]. According to [14]. Fat or shortening is an important ingredient which provides sundry advantages to cakes, like it is accountable as the integration of air in the batter in the form of small bubbles which results in increasing the volume and softness. Therefore, formulation of a structure which incorporation the air in the form of small bubbles wish advance the stability of the batter while decreasing the coalescence phenomena and the motion of the bubbles to the surface, which increase volume of the cake leading to softer crumb structure [15][16][17]. stated that fats increase the improve eating quality of cakes because they help to make a softer texture and improve the shelf life of cakes by slowing the rate of staling through their effect on the deterioration of starch. fats and emulsifiers delay time starch gelatinization by delaying water transferred to the starch granule, by the formation of complicated between polar lipids and amylose during baking, casting improvement of tenderness, moisture which contain, extending shelf-life of the cake [18]. Different problems show when fat which content is decreased in cakes, like lower volume, denser crumb, loss of flavor, and firmer eating properties. Similarly, [19], mentioned that must be kinds of cakes demand to fairly higher levels of shortening to reach the properties crumb structure. However, an excessive fat assimilation has been united to obesity [20], and cardiovascular disease problems, add to several kinds of cancer [21]. Fat decreasing in food is a source concern in our days, market demands hike for lower fat products, as fat is linked with obesity which may be linked to other non-communicable diseases [22]. The present study aimed to study the effect of using a non-dairy creamer (NDC) by partial substitution levels 10, 15 and 20% of fat on physical, chemical, microbiological and sensorial properties of quality properties of cake samples.

2. Materials and Methods

2.1. Materials:

Non-dairy creamer (NDC):
Non-dairy creamer (NDC) used in this study were obtained from Frieslandcampina Co. Kievit, Netherlands (Holland).

Wheat flour:

Wheat flour (72% extraction) was obtained from The Egyptian-French Company for Trade and Mills (Helwan, Cairo, Egypt).

Additives materials:
Sucrose, butter, fresh eggs, skim milk powder, baking powder, vanilla powder, shortening and salt, used in preparing the cake dough. This is from the local market in Cairo, Egypt.

Chemicals and Reagents:
All chemicals, solvents, pure standards, fatty acid methyl esters and reagents used in this study were of analytic quality were provided by El-Gomhouria Trading Chemicals and Drugs Co in Egypt.

2.2. Methods:

2.2.1. Preparation of cake samples:

Cake was prepared in accordance with the method described by [23] with slightly modification by utilizing the formulas displayed in Table (1). The butter was melted completely then sugar was added and mixed vigorously. Then fresh whole egg was and vanilla were added and whipped until got puff and smooth like-cream texture. After that the dry ingredients (wheat flour, baking powder and skim milk powder) were added gradually to whipped egg mixture. This mixture was mixed gently until got homogenous batter using Hand mixer (MK-H4-W, Panasonic Co, Malaysia). After getting appropriate texture the batter was poured into cups and baked at 180˚C ± 5˚C in an electrical oven (Vipinho 0448, Perfecta, Curitiba, Brazil) for 30 - 35 min. The produced cake swore leaved at ambient temperature for 2 hrs to cool, then stored in a refrigerator at 4 °C until further analysis.

Table (1):
Formulations of cake samples produced by replacing shortening with different levels of NDC.

Ingredients (g)	Treatments			
	Control	NDC-10	NDC-15	NDC-20
Wheat flour (72%)	250	250	250	250
Fresh egg	110	110	110	110
Sugar	125	125	125	125
Salt	3.50	3.50	3.50	3.50
Baking powder	12.50	12.50	12.50	12.50
Vanilla	2.00	2.00	2.00	2.00

Skim milk powder	25.00	25.00	25.00	25.00
Shortening	53.50	48.15	45.475	42.8
NDC	0.00	5.35	8.025	10.7

NDC: Non-dairy creamer; Control: 100 % shortening; NDC -10: 10% NDC; NDC -15:15 % NDC; NDC -20: 20 % NDC.

2.2.2 Physical properties of Non-dairy creamer and cake samples.

Powder solubility

Powder solubility of NDC powder was defined according to the method described by [24] with some modifications. Two grams of the powders were sprinkled over the surface with 100 mL of distilled water at 80 °C without agitation. The time taken for the powder to submerse below and disappear from the surface of water was measured and used as the wettability performance indicator of the powders.

The weight and specific volume

The weight (g) for cake was determined individually within one hour after baking the average was recorded. Both volume (cm3) and particular volume were determined and cake density was calculated according to [25][26]. Cake were weighed in grams (g) using analytical balance. The volume (cm3) of produced cakes was determined by rape seeds displacement. Particular volume was calculated using the following equation:

Specific volume = Volume (cm3)/Weight (g).

The pH value

The pH value of NDC powder was determined using an electric pH meter (Consort C 3010 Poland) according to the standard method of [27].

Bulk density

The Bulk density of NDC powder was determined using quotient of the mass and volume of a powder after transferring it to specific cylinder according to the procedures described in [28]. Bulk density was calculated using the following equation:

Bulk Density (g/L) = weight of powder (g)/ weight of water (g) X 1000

Crumb hardness

Crumb hardness of cake samples was measured at 0, 3 and 5 days after baking using a TA-XT2i texture analyzer (Stable Micro Systems, Surrey, UK). For this analysis, the cakes were sliced using an electric knife (Moulinex) and the crust was removed. The tests were conducted according to the [25] (74-09.01) method.

Color analysis

The color of crust and crumb for cake samples was determined according to the color system described by [29]. To corresponding Hunter L, a and b color coordinates according to formula given by manufacturer. The parameter L* defines the lightness [L = 0 (black); L = 100 (white)] and a* and b* are responsible for the chromaticity (+ a* – a* red and green; + b* –b * yellow and blue). For each treatment, the determinations were performed in triplicate and the results expressed as mean.

Apparent viscosity

Dynamic rheological testing was done with a Vilastic Viscoelasticity Analyzer (Vilastic Scientific, Inc., Austin, Tex., U.S.A.) at 20 °C and 4 °C, to measure apparent viscosity in CP according to the method described by [30].

2.2.3- Chemical composition of Non-dairy creamer and cake samples:

Moisture, protein (N×5.7), ether extracts, ash, fiber and total carbohydrates were calculated as a difference using the following equation Total carbohydrates (%) = 100 - (% moisture + % crude protein + % fat + % ash) were determined according to the standard method of [27]. The energy value was calculated by adding protein and total carbohydrate multiplied by 4 (cal. /100 g) added to the total lipids content multiplied by factor 9 (cal. /100 g), i.e., energy value, kcal = [(4 × % protein) + (4 × % carbohydrate) + (9 × % total lipids)] [31].

2.2.4-Fatty acids profile

Fatty acid composition of oil extracted from NDC powder was determined using gas liquid chromatography technique. Methylation process was carried out using Boron trifluoride-methanol (BF3) (20%) [27].

2.2.5. Evaluation of cytotoxicity against Vero cell line of NDC

Cell line Propagation: The cells were propagated in Dulbecco's modified Eagle's medium (DMEM) supplemented with 10% heat-inactivated fetal bovine serum, 1% L-glutamine, HEPES buffer and 50µg/ml gentamycin. All cells were maintained at 37ºC in a humidified atmosphere with 5% CO2 and were subcultured two times a week.

Cytotoxicity evaluation using viability assay and Procedure: Determination of Cytotoxicity by MTT assay and Procedure according to the procedures described in according to the procedures described in

[32], [33] with some modifications. The Cytotoxic concentration (CC50), the concentration required to cause toxic effects in 50% of intact cells, was estimated from graphic plots of the dose response curve for each conc. using Graph-pad Prism software (San Diego, CA. USA) according to the procedures described in [34], [32].

2.2.6. Microbiological analyses:

- Total plate bacterial counts:

The total plate bacterial count was determined using plate count agar medium by the pour plate technique then incubated at 30 ºC for 3 days according to the procedures described in [35].

- Mold and yeast count:

The procedures of [36] were followed for the determination of mold and yeast counts using yeast extract glucose chloramphenicol agar medium. The plates were incubated at 25 ºC for 5 days.

2.2.7- Sensory evaluation of cake samples:

Cake samples were submitted to sensory evaluation after 2 hr of baking by using 20 panelists from the staff of Food Science and Technology Department, Faculty of Agriculture, AL-Azhar University, Cairo. During the panel test, panelists rinse their mouths by water to remove any traces of residual food. Each panelist was asked to rate the liking of quality attributes according to (visual appearance, crust color, crumb color, texture, taste, odor and overall acceptability) of each sample using a 10 point hedonic scale (1= dislike extremely and 10 = like extremely) according to the method by [37].

2.2.8. Statistical analysis

Means of physical and chemical properties obtained from three replicates while sensory evaluation means obtained from 20 panelists were analyzed by (ANOVA) using the SPSS statistical package program, and differences among the means were compared using the Duncan's Multiple Range test at significant level of 0.05 [38].

Results and Discussion

1. Physical, chemical properties and microbial status of Non-dairy creamer:

The physical and chemical characteristics of NDC play a significant role in evaluating their quality, palatability and consumer acceptability, in addition to they are connected with the healthy safe quality criteria of these lipids and foodstuffs cooked or processed by utilizing them [39].

The information in Table (2) showed that the physical properties (powder solubility, bulk density, apparent viscosity and pH) of NDC which recorded 34 (s), 465 (g/L), 4.85 (CP), and 7.58, respectively.

The proximate composition and energy (kcal/100g) of NDC is showed in Table (2). The results demonstrated that the moisture content of NDC sample was 2.43%. Regarding crude fat content the data demonstrated that fat contents was 34.15% for NDC. The results also, show that NDC sample was relatively had low crude protein (1.93%). The same trend was also observed for ash content, since NDC was having low ash contents 5.5%. On the other hand. NDC was exhibited the highest carbohydrate content 55.59. The energy content was 538.87 kcal/100g for NDC. This is consistent with results reported by [40], [41].

Table (2):
Physical, chemical properties and microbial status of Non-dairy creamer.

physical and chemical properties	Non-dairy creamer
Physical properties	
Apparent viscosity (CP)	4.85
Powder solubility (s)	34
Powder Bulk Density (g/L)	465
pH	7.58
Chemical properties % (on wet weight basis)	
Moisture	2.43
Crude protein	1.93
Crude fat	34.15
Ash	5.5
Dietary fiber	0.40
Total Carbohydrates (Nitrogen free extract)	55.59
Energy (kcal/100g)	538.87
Microbial status (cfu/g)	
Total plate bacterial counts	50
Mold and yeast counts	ND

2. Fatty acid composition of non-dairy creamer:

From Table (3) noticed that the fatty acid profile of fat extracted from NDC powder contain saturated fatty acids 87.28% and the highest saturated fatty acids was lauric acid (C12:0) was 44.22%, while unsaturated fatty acids were 12.72% and the highest unsaturated fatty acids was oleic acid (C18:1)7.41%. These results resemble those stated by [42] [43]. In the same Table observed that trans-fatty acid was 2.07%.

These values may be due to the partial hydrogenation that takes place on the oils used in the production of NDC.

Table (3):
Fatty acids profile of oil extracted from non-dairy creamer.

Fatty acid %	Non-dairy creamer
(C8:0)	3.21
(C10:0)	3.31
(C12:0)	44.22
(C14:0)	11.11
(C16:0)	15.12
(C18:0)	10.01
(C20:0)	0.3
(C14:1)	0.20
(C16:1)	1.21
(C18:1)	7.41
(C18:2)	1.90
(C18:3)	2.00
TSFA	**87.28**
TUSFA	**12.72**
Total Trans fatty acid	**2.07**

TSFA: saturated fatty acid; TUSFA; total unsaturated fatty acid.

3. Evaluation of cytotoxicity against Vero cell line non-dairy creamer

The in vitro cytotoxicity of NDC powder was evaluated against normal fibroblast Vero cells using the MTT assay according to the procedures described in [32] [33]. Table (4) shows the cell viability % of NDC samples at various concentrations (0, 31.25, 62.50, 125, 250, 500, and 1000 µg/ml). It was generally observed that the NDC powder at concentrations (0, 31.25, 62.50, 125, and 250 µg/ml) had no cytotoxic effect on Vero cells. Further, high concentrations (500 and 1000 µg/ml) showed a negligible cytotoxic effect on Vero cells, and the viable cells recorded 96.81% and 92.46% at 500 and 1000 µg/ml of NDC samples. The obtained result showed that the NDC powder had no cytotoxic effects activity against Mammalian cells from (Vero) cells was revealed to using MTT assay under these experimental conditions.

Table (4):
Evaluation of cytotoxicity against Vero cell line for non-dairy creamer.

Sample conc. (µg/ml)	Viability %	Inhibitory %	S.D. (±)
1000	92.46	7.54	1.38
500	96.81	3.19	0.75
250	99.42	0.58	0.56
125	100	0	-
62.5	100	0	-
31.25	100	0	-
0	100	0	-

4-The proximate chemical composition of cake samples.

From in Table (5) introduces chemical composition of cake treatments which contain NDC at various levels and control sample. Moisture which contain in is one of the acceptable sensory attributes in bakery products, being generally connected with a slight product [44]. Data tabulated in Table (5) demonstrates that the moisture which contain of cake treatments increased as the fat replacement level increasing. The cake treatments made with NDC had higher moisture which contain in comparison with control sample which could be explained that by the NDC which has the ability to bind water. The highest significant ($P < 0.05$) moisture which contain was registered for NDC-20 sample (38.42%) whereas the lowest moisture which contain was registered for control treatment (35.23 %). These findings went along with results of [45].

Concerning, the lipid which content replacing of shortening with NDC resulted in reduction lipid level of cakes which is reduced as the level of replacement raised, so cake treatment NDC -20 which formulated with replacing of shortening by 20% NDC exhibited a significant ($P < 0.05$) decreased ratio (37.25%) of lipids related to control sample. The given values go along with that given by [46][47].

Furthermore, which contents of total carbohydrates, ash and fibers were significantly ($P < 0.05$) raised as the replacement level of fat raised, (from 29.19 to 33.09; 2.03 to 2.14 and from 1.55 to 1.70g/100 g successively). On the other hand, the caloric values of cake treatments were reduced as the substitution level raised due to fat is the main source of energy in cake which is reduced with substituting with NDC, the highest caloric value was registered for control sample (344.76 kcal/100g), whereas the lowest caloric value was noticed to cake treatment in which Shortening was thoroughly substituted with NDC (293.71 kcal/100g).

5. Physical properties of cake samples:

Physical characteristics are very significant quality criteria for cake, which greatly affect consumer tendency, and they directly connected with the kind and quantity of fat, as fat enhances aeration of the batter and stabilizes the air bubbles formed during batter mixing [19]. As shown in the given results (Table 6), it could be observed that the cake specific volume gradually increased with increasing NDC substitution level, whereas the specific volume was (3.28, 3.31 and 3.33 cm3/g) for cake making with 10, 15 and 20% NDC substitution level, in comparison

with the control cake treatment making with 100% fat which registered 2.75 cm3/g.

Table (5): Effect of fat substituting with (NDC) on proximate chemical composition (g/100 g on wet weight basis) and caloric value of cake samples.

Treatments *	Moisture content	Total proteins	Total lipids	Ash content	Total Dietary fiber	Total carbohydrate	Caloric value (kcal/100g)
Control	35.23^{c}±0.1	12.00^{a}±0.05	20.00^{a}±0.10	2.03^{c}±0.01	1.55^{c}±0.03	29.19^{d}±0.03	344.76
NDC-10	35.96^{c}±0.1	12.05^{a}±0.02	17.71^{b}±0.01	2.06^{b}±0.01	1.62^{b}±0.01	30.60^{e}±0.02	329.99
NDC-15	36.34^{b}±0.2	12.08^{a}±0.04	15.74^{c}±0.02	2.07^{b}±02	1.63^{b}±0.01	32.14^{b}±0.03	318.54
NDC-20	38.42^{a}±0.2	12.10^{a}±0.05	12.55^{d}±0.05	2.14^{a}±0.01	1.70^{a}±0.02	33.09^{a}±0.02	293.71

*Control: 100 % shortening; NDC -10: 10% NDC; NDC -15: 15 % NDC; NDC -20: 20 % NDC. (M±S.D) = Mean ± Std. Deviation. Values with different small letters in the same column are significantly different ($p<0.05$).

The same behavior was also noticed in testing cake treatments for volume, which was gradually increased by raising the percent of NDC from 10 to 20%, whereas it was of increased from 180.5 to 183.9 cm3 respectively, when compared with 151.6 cm3 recoded by cake making with 100% fat. This finding resemble [48].

On the contrary, the weight of the cake was gradual slight raised by increasing of the NDC, which it ranged from 55.10 to 55.16 (g) respectively, in comparison with control samples (55.20 g). The former finding agrees with that stated by [23].

The NDC formula contains a source of emulsifiers and some ingredients that act as cake improvers that increase the physical quality of the product.

These findings are similar to those stated by [1], who found that hydrophilic emulsions in NDC promoted a uniform dispersion of fats, with the presence of entrapped air cells, and thus providing many sites for water vapor to expand during baking and the time required for the production of fermented gases to expand the air cells in the cake formula and thus increase the volume.

6. Crumb hardness, crust and crumb color of cake samples:

Fats have a positive influence on bakery products texture, color and significant to make cake tender for a long time. Also from data in table (7) revealed that the influence of fat substituting with NDC on crumb hardness (texture) of cake treatments. It can be noticed that the decrease of fat content by substituting with NDC (Table 5) raised the hardness of cake treatments as compared to control which is connected with the rise in the volume and specific volume of cake treatment which contain NDC (Table 5). These results agree with [19], [49].

Table (6): Effect of fat substituting with NDC on physical properties of cake samples.

Treatments*	Weigh (g)	Volume (cm^3)	Specific volume (cm^3/g)
Control	55.20a±0.10	151.6b±2.8	2.75b±0.5
NDC-10	55.10a±0.10	180.5a±1.0	3.28a±0.01
NDC-15	55.13a±0.05	182.6a±1.0	3.31a±0.01
NDC-20	55.16a±0.15	183.9a±1.0	3.33a±0.01

*Control: 100 % shortening; NDC -10: 10% NDC; NDC -15: 15 % NDC; NDC -20: 20 % NDC. (M±S.D) = Mean ± Std. Deviation. Values with different small letters in the same column are significantly different ($p<0.05$).

Table (7): Effect of fat substituting with NDC on crumb hardness, color of crust and crumb for cake samples

parameters	**Crumb hardness (g)**			**Crust color**			**Crumb color**		
	storage days			**L***	**a***	**b***	**L***	**a***	**b***
Treatments	**0**	**3**	**5**						
Control	380^{b}±10	780^{a}±10	1029^{a}±1	47.73^{d}±1	15.25^{a}±0.05	21.00^{a}±1	69.00^{c}±0.5	9.73^{a}±0.03	18.0^{d}±0.01
NDC-10	405^{a}±5	660^{b}±5	820^{b}±10	49.95^{c}±0.01	15.07^{b}±0.02	20.33^{ab}±0.03	69.58^{c}±0.02	8.25^{b}±0.05	18.12^{c}±0.01
NDC-15	415^{a}±5	580^{c}±8	790^{c}±12	51.01^{b}±0.01	14.88^{c}±0.01	19.45^{b}±0.05	71.22^{b}±0.02	7.74^{c}±0.01	18.35^{b}±0.05
NDC-20	420^{a}±10	550^{d}±8	780^{c}±5	53.54^{a}±.04	13.95^{d}±0.02	18.75^{ab}±0.05	72.49^{a}±0.04	7.07^{d} ±0.01	18.70^{a}±0.02

.*Control: 100 % shortening; NDC -10: 10% NDC; NDC -15: 15 % NDC; NDC -20: 20 % NDC; L*: brightness; a*: redness and +b* yellowness ;(M±S.D) = Mean ± Std. Deviation. Values with different small letters in the same column are significantly different ($p<0.05$).

Although, the addition of fat in the cake treatments was reduced and replaced with NDC, the results indicate a higher and better aeration capacity for the crumb structure, consequently a reduction in the rate of hardness during the storage period at ambient temperature (25±5 °C) up to 5 days, which was recorded (820, 790 and 780 g) for samples (NDC-10, NDC-15 and NDC-20) respectively, compared to the control sample which recorded (1029 g) after 5 days. This is due to the high content of NDC from emulsifiers and stabilizers, in addition to contain a high percentage of fat up to 34.15% (Table 2), which makes the use of NDC in cake formula an alternative to fat and cake improver. These results agree with [50], [19].

The color is considered one of the important main properties in the appearance of a cake, as this is mutual with the texture and flavor [39]. The results of color for cake produced by using 100% white shorting as a control sample and cake treatments which substituted with 10, 15 and 20% NDC powder are immediately after processing are presented in Table (7). Crust and crumb color of cake treatments different with the amount and the type of the completed materials the crust became lighter since the NDC level raised in comparison with that of control sample. No big varied in crust yellowness existed among the varied NDC treatments. Relating to crumb color, in generally, as NDC level raised L\ and b\ values slight increased whereas a\ value decreased and the crumb color got lighter. The crumb of the control sample was darker and more yellow compared to the analyzed cakes.

In accordance with the findings elucidate in Table 7 the values for L*, a* and b* for the crust color of the cake ranged from 47.73 to 53.54, 15.25 to 13.95 and 21.00 to 18.75, respectively, . The highest values for these parameters were noticed for NDC-20 sample. As foreseeable, owing to its own color, NDC affected all the color parameters assessed. Moreover, NDC contributed to making the crumb color light which may be owing to the ingredients of NDC which contain emulsifiers and stabilizers (high L*), with increasing values of yellow color (slight increase b* and slight decrease a*). These results go along with [19].

In general, results obvious that the color of crust and crumb for cake treatments containing NDC were lighter than control sample. It was common that during cake baking, the crumb, dose not reach a degree crumb does not reach a degree above 100 °C, so the Millard or caramelization reactions fail to appear. Hence, the result of crumb color of tested cake was as a result of the color of the utilized substituted materials and their interactions (NDC contained natural surfactants (mono- and diglycerides) and animal protein [51].

3.4. Microbiological quality of cake samples:

The microbiological status of cake samples was evaluated each three days during storage 25±1°C for 12 days. From Tables (8) and (9), it could be observed that cake treatments substitution of fat by different levels of NDC (10, 15 and 20%) led to their free from total bacterial count (TBC) and mold yeast (YMC) until 3 days at ambient storage (25°C), while the microbial growth of total bacterial appeared at the lower substituted cakes 10% from fat (NDC-10) and control sample at 6 days of storage. According to [52] [53], all results recorded up to 12 days are within the permissible limits of TBC and YMC.

Generally, it could be noticed that the increase rate in growth of TBC and YMC in cake treatments with NDC it starts after 6 days of storage period, but the increase of NDC powder in cake formula samples decreased growth of TBC and YMC than cake control sample during storage period. This may be due to that NDC as source of antioxidant and the free water is absorbed in the cake formula, and therefore it is not available for microorganisms so, improved shelf life [3].

3.5-Sensory evaluation of cake samples.

From data in Table (10) introduces the outcomes of the sensory evaluation of cakes that were developed with fat replacement by the NDC powders. It can be noticed that all qualities offered scores between (8) and (9), demonstrating that cake were assessed as ‘‘liked extremely”. The whole acceptability was approximately 8.00, which asserted that the cakes are regarded as rational by the panelists as stated by [54] [55], who stated that a product is regarded as acceptable in relation to its sensory properties, it must get a minimum score of 70%. Table (10) reveals that cake combined with substitution of fat with NDC powders exhibited convergent with control samples but non-significant different for all the parameters when compared to other NDC powders containing cake, while it non-significantly different in the whole acceptability as compared to control sample. Showed that cake produced by partially substitution of fat by NDC powders at level (10, 15 and 20 %) distinguished with good sensory properties and better acceptability when comparison with control sample.

In general, sensory evaluation in this study demonstrated that there was no statistically significant distinction between the control cake sample and the samples which contain NDC with different levels (10, 25 and 20%).

Table (8):Total Bacterial count (cfu/g) of cake samples containing NDC powders.

Storage period at 25±1°C (days)	Total Bacterial Count (cfu/g)			
	Control	NDC 10%	NDC 15%	NDC 20%
0	ND	ND	ND	ND
3	ND	ND	ND	ND
6	20	10	ND	ND
9	40	30	20	ND
12	60	50	30	20

ND: Not detected.

Table (9): Mold and Yeast Count of (cfu/g) of cake samples containing NDC powders.

Storage period at 25±1°C (days)	Mold and Yeast Count (cfu/g)			
	Control	NDC 10%	NDC 15%	NDC 20%
0	ND	ND	ND	ND
3	20	ND	ND	ND
6	30	10	ND	ND
9	50	20	10	ND
12	80	40	30	20

ND: Not detected.

Table (10): Sensory evaluation of cake samples.

Treatments	Sensory property**						
	Crust color	Crumb color	Texture	Appearance	Odor	Taste	Overall acceptability
Control	$8.2^{c}\pm0.2$	$8.2^{c}\pm0.2$	$8.2^{c}\pm4$	$8.4^{c}\pm0.2$	$8.4^{b}\pm0.3$	$8.7^{c}\pm0.3$	$8.7^{c}\pm0.2$
NDC 10%	$8.6^{b}\pm0.3$	$8.8^{b}\pm0.2$	$8.2^{c}\pm3$	$9.0^{b}\pm02$	$8.4^{b}\pm0.3$	$8.9^{b}\pm0.2$	$8.8^{c}\pm0.2$
NDC 15%	$9.5^{a}\pm0.1$	$9.5^{a}\pm0.3$	$8.8^{b}\pm0.3$	$9.5^{a}\pm0.2$	$8.9^{a}\pm0.4$	$8.9^{b}\pm0.2$	$9.3^{b}\pm0.1$
NDC 20%	$9.5^{a}\pm0.2$	$9.6^{a}\pm0.9$	$9.5^{a}\pm09$	$9.5^{a}\pm0.4$	$9.0^{a}\pm0.3$	$9.1^{a}\pm0.3$	$9.5^{a}\pm0.2$

*Control: 100 % shortening; NDC -10: 10% NDC; NDC -15: 15 % NDC; NDC -20: 20 % NDC. Values with different letters in the same column are significantly different ($p<0.05$)

Conclusion:

The rise of consumer demand for food and drink products which contain natural ingredients is a main tendency in the food industry. NDC is sorted out as powdered, microencapsulated oils produced by combining functional oil, carbohydrate products, emulsifiers, or stabilizer, besides other food additives and form a stable mixture with a whitening influence [56]. NDC is produced with no milk and mainly involve a cream-replacement (usually from coconut and palm kernel oils). NDC, which are available in powdered, liquid, or frozen form, supply flavor and whiten foods the powdered non-dairy creamer is preferred due to its high stability while handling and longer shelf life owing to its lower moisture which content and water activity. The replacement of fat by various levels of NDC to enhance the quality attributes of the cake and produced low fat cake with keeping good physiochemical and sensory attributes.

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