Untraditional Sources for Producing High Nutritional Value Bakery Products.

Abstract : Eggplant puree (EP) (25, 50, 75 and 100%) was used to replace fat and egg in the muffins production . Muffins prepared with 25% (EP) had a higher volume than control Muffins . Muffins volume was alikeness between control muffins and the sample used 50% (EP). At 100% replacement level, the muffins volume is minimal. Low-fat and egg muffins with (EP) had higher moisture and minerals also less calories than control. Replacing baking butter by (EP) gave a significant rising in springiness hardness, and chewiness, and a limited result of cohesiveness. But, there were no inequality between control muffins and the acceptance of low (fat and egg) muffins up to 75% . Adding (EP) did not result in undesirable variations in color. Likewise high moisture content in (EP) muffins was acceptable by the panelists. Results clarified that (EP) is an acceptable fat alternative in muffins and efficient in reducing the amount of fat and calories, likewise (EP) could be used as egg replacer in muffins and cakes. Furthermore, during storage moisture loss and increase of muffins hardness was observed in produced muffins.

Introduction

Eggplants (Solanum melongena L.) are non-climacteric fruits that have been found growing wild in Indian forests and now ranked among the top ten healthiest foods in the world. After potatoes and tomatoes, eggplant is the third most important solanaceous crop in the world [1]. Eggplant is an important economic vegetable crop with 51.288 million tons produced worldwide. Egyptian output ranks third in the world, with 1.194 metric tons produced from 0.485 million hectares,accounting for 2.3 percent of global production [2]. Eggplant contains all the necessary vitamins, minerals, nutritious fiber, protein, antioxidants, and phytochemicals with scavenging properties [3]. A significant source of fiber is eggplant [4]. Dietary fiber, which includes celluloses, hemicelluloses, lignin, pectic materials, gums, mucilage, and certain polysaccharides, is a type of carbohydrate polymer that human digestive enzymes find difficult to readily digest [5]. Foods high in dietary fiber have been linked to a lower risk of gastrointestinal disease, hypercholesterolemia, colon cancer, and constipation as well as a lower incidence of obesity, lower blood pressure, and increased satiety [6]. There are 98 different species of eggplant, each with a unique form and color, they lower the risk of cholesterol, premenstrual syndrome, amenorrhea, antenatal anemia, cancer, and cardiovascular illnesses, additionally, they remove harmful substances, promote weight loss, and control diabetes. Finally, eggplant's leaves, stem, fruit, and roots are employed in food, fuel, ceremonies, medicine, and ornament. One of the most ten important origins of healthy foods in the globe, also its one from the best categories grown throughout the globe, is eggplant. [7] and [8]. Due to its nutritional qualities, particularly for being a source of fiber [9], and antioxidants [10], eggplant has become more significant. Dietary fiber consumption was linked to a lower risk of numerous diseases, including gastrointestinal disorders, cardiovascular disorders, diabetes, hypertension, and obesity [11]. By the end of 2026, the market for plant-based, the global vegan egg substitute market is expected to grow at a CAGR of 5.6% in the forecast period of 2022-2027 to reach a value of USD 1.48 billion by 2026.

Egg substitutes is expected to be worth over $1.5 billion, expanding by 5.8% from 2016 to 2026. Many aspects s, such as consumer requirements, allergy reduction, improving food safety, more healthy, nutritious profiles, to handle and storage easier, make it more functional, less price and reduced-price instability, and environmentally safe, are driving the food industry's to be more interested in using egg substitutes [12]. The production of foam in cakes is significantly influenced by egg proteins. The egg is one of the main ingredients for preparing cakes for providing texture and nutrition. The egg is necessary to foam formation, binding, flavorings, coloring agents and many other properties, also the baking industry during the past years, low-fat and low-calorie food products have been always studied and try to be more developed to meet the customer needs for more healthy food options [13]. The applications of fat replacers have successfully formulated low-fat and low-calorie food products which are preferable by customer ’s choices. Rice starches, okra gum, cocoa fiber mung bean squash, as well as purees of fruit and vegetables, are examples of butter replacers used in bakery products [14–20]. One of the primary elements for making cakes are eggs, which gives them texture and nutrients. The egg is required for several different qualities, including foam creation, binding, flavorings, and coloring agents [13]. In order to satisfy consumer demand for healthier food options, the baking industry has been actively researching and developing low- fat and low-calorie food products over the years [13]. A fat replacer is a component that can be utilized to deliver some or all of the functions of fat while producing less calories products than fat, according to the American Dietetic Association [21]. Fat substitutes are used in a wide variety of food products, some of which include meat, dairy, and baked goods. For instance, fat can promote leavening, softness, and a finer crumb in cakes by trapping air cells when the batter is being creamed [22]. Due to the gelatinization of the starch and the coagulation of the egg proteins, this structure is then set during baking [22].

- **The Aim of investigation:** Using eggplant puree to reduce fats and egg in bakery products to reduce calorie and increase nutritional value of cake (muffins) also, technological and sensory evaluation of muffin produced. Maximizing the use of eggplant from an economic point of view, as it is a cheap and available product in the Egyptian market ,maximizing the health benefits of eggplant by producing a product with high nutritional value and low in fat ,take advantage of dietary fiber in vegetables, producing a new product with high nutritional and biological value , take advantage of various antioxidants from their natural sources , improving the quality characteristics of products (sensory qualities), especially color and using natural vegetables as fat substitutes in bakery products.

Material and Methods

Eggplant and baking ingredients were purchased from the local market in Cairo, Egypt. Chemicals. Eggplant (Solanum melongena L.), skimmed milk powder, sugar , butter, cocoa powder, row chocolate were obtained from the local market, Cairo , Egypt. All chemicals were of analytical reagent grade used in this study were of analytical grade and purchased from Sigma Co.

- ***Eggplant puree preparation***

Methods Preparation of eggplant puree: The eggplant free of seeds (Solanum melongena L.) were selected, it was washed with tap water to remove any soil particle and dirt. it was peeled and shredded into rings in a stainless steel vessel a 100 ml water with 0.2% calcium propionate was add and boiled

for 8-10 minutes at 100^{O}C then left to cool at room temperature, then blended until smooth texture obtained and finally put in plastic bags in freezer. [23]

- ***Muffins Preparation***

Methods: Preparation of muffins blends: The eggs, sugar and vanilla were mixed and creamed mechanically using electric mill for 10 min until soft and fluffy. The flour, skimmed milk powder, baking powder and cocoa were sieved then added and mixed slightly until soft dough was formed. Eggplant puree and row chocolate were substituted with egg at different levels ,25, 50, 75 and 100 %. The dough was transferred to a greased baking pan and baked in an oven at 180 °C o for 35 min. After cooling for 30 min, muffins were packed and used for evaluation of various chemical, physical and sensory characteristics [24].

Table(1) Formulations of Muffins samples prepared by replacing fat and eggs with eggplant

	Control	S1	S2	S3	S4	S5
Wheat flour 72% (g)	100	100	100	100	100	100
Sugar (g)	95	95	95	95	95	95
Fresh egg (ml)	100	100	75	50	25	-
Batter (g)	15	-	-	-	-	
Eggplant puree (g)	-	15	40	65	90	105
Skimmed milk powder (g)	10	10	10	10	10	10
Raw chocolate (g)	5	5	5	5	5	5
Fine cacao powder (g)	10	10	10	10	10	10
Pure villain (g)	1	1	1	1	1	1
Baking powder (g)	10	10	10	10	10	10
Water (g)	5	10	15	20	25	30
Citric acid (g)	0.1	0.1	0.1	0.1	0.`1	0.1
Ca propionate (gm)	0.3	0.3	0.3	0.3	0.3	0.3
Lecithin (gm)	1.5	1.5	1.5	1.5	1.5	1.5

- ***Storage of Muffin***

The muffins were cooled at room temperature, sealed polyethylene bags and then stored at 18 ± 2°C for 14 days (except for 100% replacement due to fungal or microbial contamination). Samples were evaluated every 2 days for mold free shelf life, moisture and hardness during storage period.

- ***Chemical Analysis***

Muffins were analyzed for moisture, protein, fat and ash according to AOAC [25]. Carbohydrate content was calculated by difference. The analyses were performed in triplicate. Total calories were calculated by the formula of [26] as follows:

Total calories = Fat x9 + Protein x 4 + Total carbohydrate x 4

- ***Physical Properties Muffins***

Specific gravity of muffins was determined as the ratio of the weight of a standard container filled with batter to that of the same container filled with water. The specific volume was calculated as the ratio of apparent volume to weight. The batter pH was determined according to the AACC [24] method. The measurements were performed in triplicate. Muffins height was measured to the nearest millimeter with a micrometer. Volume (ml) was measured by seed displacement [27], and weight (g) was determined according to AACC method [27]. Water activity (aw) was measured with a Rotronic Hygro Lab EA10-SCS (Switzerland) aw meter. The measurements were performed in triplicate.

- ***Profile Texture Analysis***

Crumb hardness, cohesiveness and springiness were determined according to [28], by using a Texture Profile Analyzer (TPA). Muffins texture parameters were determined by a universal testing machine (Brook field Engineering Lab. Inc., Middleboro, MA 02346- 1031, USA). A 25-mm diameter cylindrical probe was used in a TPA at 2 mm/s speed.

- ***Sensory Evaluation***

Muffin samples were left to cool (25°C ± 2) for 4 h after packing then subjected to organoleptic characteristics. Muffins were judged for crust and crumb color, texture. taste, flavor, and overall score by 10 well trained panelists (five males and five females) from the staff of Food Technology Research Institute as described by [29].

- ***Muffins staling:***

Alkaline water retention capacity (AWRC %):

The staling rate of muffins samples were determined by alkaline water retention capacity as described by [30]. The percentage of the absorbed alkaline solution to 5 g of baked product was calculated as follows:

$$\%\,\mathrm{AWRC} = \frac{W2 - W1}{W_s}$$

W1 = Weight of empty tube.

W2 = Weight of tube with sample after centrifuge. Ws = Weight of sample.

- ***Statistical Analysis***

The analytical data were analyzed using SPSS 16.0 software. Means and standard deviations were determined using descriptive statistics. Comparisons between samples were determined using analysis of one-way variance (ANOVA) and multiple range tests. Statistical significance was defined $P \leq 0.05$.

- ***Results and Discussion***

- ***Chemical Analysis of Muffins***

Tables (2) show chemical analysis of muffins used eggplant as fat and egg replacer muffins. It was observed in table no. (2) that as a result of replacing fat and eggs with eggplant purée, which is high in dietary fibers, which led to the association with a greater amount of water during the dough mixing process, from 24.60 to 33.41 . There was also a decrease in the percentage of fats and proteins in the muffin, respectively, from (17.50 to 2.46) and (8.70 to 4.70) as a result of replacing eggs and fat with purée which was lower in its content of both fat and protein. As for the total dietary fibers, and both soluble and insoluble dietary fibers, an increase occurred as a result of the use of puree, which is loaded with high amount of fibers. Carbohydrates, increased as shown in the table from (71.87 to 88.00), and this is expected due to the decrease in energy, which decreased due to the decrease in protein and fat and the increase in the percentage of fiber. These results agree with [31]. Also [32] indicated that raise to the high moisture content of vegetable squash (94.74 and 88.77) compared to moisture of butter (17.94%). Also, the high fiber content of purees could affect the moisture content as reported by [33] when studying the influence of the peach dietary fiber in reduced-fat muffins. [34] showed that high water-holding capacity of dietary fib

caused by water retention in mixtures and exhibited vaporizing during baking, resulted in a high content of moisture. Previous studies confirmed a similar trend in which incorporation of a fat replacer increased the protein content of baked goods, either significantly or insignificantly [35,36]. As, fat content of muffins decreased parallel with the reduction of the percentage of fat significantly ($p < 0.05$) from 17.50 to 2.46. Fiber enlarged, with the enlargement in the different replacement levels, these results because of high content of fiber in (EP) [37, 38]. As expected, because of to the reduction in fat content of substituted muffins, their caloric value was significantly reduced. These results agree with the research results of [39], who reported the decrease in caloric values in sponge cakes which was produced from mango pulp and peel dietary fiber.

Table 2. Chemical Analysis of Muffins made by using eggplant Puree as a Fat Replacer.

	Moisture %	Protein %	Fat%	Ash%	Total dietary fiber%	Insoluble dietary fiber%	soluble dietary fiber %	Total carbohydrate	Energy
Control	24.60 ^{a}	8.70±0.03^{a}	17.50±0.01^{a}	1.42±0.06^{b}	0.51±0.03^{b}	0.31±0.02^{b}	0.20±0.03^{a}	71.87±0.05^{c}	479.78±0.03^{a}
S1	26.25 ^{a}	8.80±0.04^{a}	4.31±0.02^{b}	1.95±0.03^{b}	0.90±0.05^{b}	0.50±0.04^{b}	0.40±0.06^{b}	84.04±0.03^{b}	410.15±0.03^{b}
S2	27.80 ^{a}	7.95±0.01^{a}	3.95±0.06^{b}	2.13±0.05^{b}	1.22±0.02^{b}	0.68±0.05^{b}	0.54±0.04^{b}	84.75±0.08^{b}	406.35±0.03^{b}
S3	28.38 ^{b}	6.82±0.06^{b}	3.48±0.08^{b}	2.36±0.08^{a}	1.50±0.04^{a}	0.80±0.04^{a}	0.70±0.08^{a}	85.84±0.04^{a}	401.96±0.03^{c}
S4	30.52 ^{b}	5.75±0.02^{b}	2.96±0.04^{b}	2.51±0.02^{a}	1.80±0.03^{a}	0.98±0.06^{a}	0.82±0.02^{a}	86.98±0.06^{a}	397.56±0.03^{c}
S5	33.41 ^{b}	4.70±0.05^{b}	2.46±0.06^{b}	2.70±0.01^{a}	2.12±0.07^{a}	1.12±0.07^{a}	1.00±0.08^{a}	88.00±0.04^{a}	392.94±0.03^{b}
LSD	3.12	2.10	6.65	0.53	0.71	0.411	0.340	3.86	5.74

*Values are means of three replicates ±SD, number in the same row followed by the same letter are not significantly different at 0.05 level.

- ***Physical Properties of Muffins***

Table (3) presents physical properties of muffins Substituted with fat and egg by eggplant puree of muffins with and without fat and egg replacer. Weight loss occurred because the dough from the base when it was formed needed more water during mixing and rubbing

process as a result of the mullet containing a high percentage of solid dietary fibers that led to the absorption of more water during rubbing . Also, humidity, was higher than the control in all samples, because the samples from S1 to S5 began to gradually decrease the content of eggs with complete absence of fat, whose presence with eggs helps reduce the use of water for rubbing . So, the decrease in weight, as a result of the loss of moisture in the oven during baking, so the samples were of high humidity when compared to the control. A heighten was observed in both the control and sample (1, 2) and this was due to the presence of fat, eggs and their emulsions, which led to the formation of a good sponge, and thus led to a rise in height. This could be related to the higher moisture content, which can produce more steam and therefore, increased production of air cells in muffins crumbs. Thereby, it causes light, porous structure, high volume and low density of the muffins. [40] observed that the amount of air captured was lower in muffin batter, which is characterized by high density and coherence. Muffins with increasing the level of replacement more than, the height decreased from (5.23cm) in control to (3.25 cm) in sample no. S5. [41] explained that shortening combine a greater amount of air but does not keep the air on baking. Observation showed that the batter prepared with puree (eggplant) was more sticky than the control. But for the rest of the samples, which contained high percentages of vegetable puree, and low percent of egg gave similar results as control, this is due to the effect of soluble fibers, which play a similar role as emulsions, but in a less extent, and this also applies to each of the volume - specific volume - weight, while density increased as a result of increasing the proportion of puree from (0.51 - 0.65). These results agree with work of [42]. As It could be noted that the density of the control was the low as S1 (0.51 g/cm3), but S5 was the highest (0.65 g/cm3). This may be related to the emulsion properties of egg lecithin that play a role in reduction of interfacial tension in liquid and gas bubbles along with the formation and improvement of the stabilization of air bubbles. These findings are in agreement with those presented by [43] who found that the density of egg muffins was the lowest compared with egg-free muffins (banana, chia and soy milk powder). [44]

Table (3). Effect of Substitution of fat and egg by eggplant puree on *Physical Properties* of Muffins.

Muffin s cake samples	Highest (Cm)	Weight (g)	Volume (ml)	Specific Volume (g/Cm3)	density (g/cm3)
Control	5.23±0.06^{a}	70.12 ±0.09^{a}	135.15±0.14^{a}	1.92±0.04 ^{a}	0.51 ±0.03 ^{b}
S1	5.15±0.08 ^{a}	70.28 ±0.09^{a}	136.30±0.11^{a}	1.93±0.06 ^{a}	0.51±0.04 ^{b}
S2	4.75±0.05 ^{a}	69.61 ±0.06^{a}	128.85±0.13^{a}	1.85±0.07^{a}	0.54 ±0.03^{b}
S3	4.35±0. 11 ^{b}	69.20±0.08 ^{b}	122.70±0.12^{b}	1.77±0.09 ^{a}	0.56±0.06^{a}
S4	4.00 ±0.09^{b}	68.90 ±0. 10^{b}	114.92±0.1^{b}	1.66 ±0.04^{b}	0.60±0.04 ^{a}
S5	3.25±0.04 ^{c}	68.72±0. 12 ^{b}	105.55±0.14^{c}	1.53 ±0.08^{b}	0.65±0.04 ^{a}
L.S.D	0.72	0.81	12.68	0.18	0.96

*Values are means of three replicates ±SD, number in the same row followed by the same letter are not significantly different at 0.05 level.

- ***Texture Profile Analysis***

Texture profile was studied on muffins to obtain the textural parameters (hardness, cohesiveness, and springiness) of muffins prepared, as shown in the Table (4). Substitution of fat and egg by eggplant puree resulted in a significant increase in hardness, chewiness, cohesiveness and springiness. Hardness, chewiness, cohesiveness and springiness of substituted muffins significantly increased after 30 days from control till sample no. (S5 100%) replacement respectively (10.22 to 11.96), (6.31 to 7.90), (1.03 to 2.13) and (2.23 to 3.3). This is as a result of water loss in a faster way for the samples that contained high percentages of puree, because the correlation between the samples was by binding the soluble fibers, because of reduced fat. So weaker bonds than the correlation between emulsions, fats and water present in the eggs. These results agree with [33] and [45] who reported that fiber-based butter replacers increased the hardness in muffins. [46] and [47] mentioned that the increase in hardness refers to the decrease in the amount of air bubbles, which are incorporated in the dough during mixing and expand during baking process, because of reduced fat. While [48] reported that narrow bubble size distribution in small areas resulted in significantly softer cakes. [49] observed that the cake had a softer texture when a homogenous distribution of bubbles was observed in the dough, whereas when the bubble size distribution was wide, the cake tended to have a harder texture. This total work represents hardness, which was found to increase in fat and egg -replaced muffins. Control muffins were less hard.

Table (4). Effect of Substitution of fat and egg by eggplant puree on Texture analysis profile for Muffins

Treatment	Hardness				Chewiness				Cohesiveness				Springiness			
	Zero time	10 days	20 days	30 days	Zero time	10 days	20 days	30 days	Zero time	10 days	20 days	30 days	Zero time	10 days	20 days	30 days
Control	9.16±0.09 c	9.31±0.10 c	9.74±0.12 c	10.22±0.13 c	5.23±0.11 c	5.68 ±0.11 b	5.98±0.13 c	6.31±0.10 c	0.30±0.05 b	0.58±0.09 b	0.77±0.10 c	1.03±0.07 b	1.78±0.06 b	1.92±0.04 b	2.11±0.11 b	2.23±0.08 b
S1	9.20 ±0.07 c	9.56±0.10 c	9.93±0.10 c	10.58±0.10 c	5.31±0.08 c	5.70±0.13 b	6.07±0.09 b	6.52±0.13 b	0.30±0.07 b	0.58±0.09 b	0.79 ±0.13 c	1.17±0.09 b	1.80±0.04 b	1.96±0.07 b	2.13±0.10 b	2.24±0.07 b
S2	9.70±0.08 b	10.24±0.08 b	10.76±0.12 b	11.31±0.13 b	5.62±0.10 b	6.00±0.12 b	6.51±0.12 b	6.97±0.10 b	0.31±0.05 b	0.71±0.08 a	1.1±0.12 b	1.42±0.10 b	2.12±0.03 b	2.39±0.05 b	2.62±0.11 b	2.81±0.10 b
S3	9.91±0.09 a	10.48±0.10 b	11.11 ±0.13a	11.55±0.11 a	5.88±0.13 b	6.48±0.14 a	6.79±0.09 a	7.21±0.11 a	0.32±0.04 a	0.75±0.05a	1.22 ±0.10 b	1.62±0.08a	2.36±0.05 a	2.50±0.08 a	2,78±0.09 a	2.92±0.10 a
S4	10.32±0.10 a	10.75±0.09 a	11.28±0.09 a	11.76±0.12 a	6.24±0.15 a	6.53±0.15 a	6.92±0.11 a	7.58±0.12 a	0.33±0.06 a	0.77 ±0.06 a	1.41±0.08	1.80±0.12 a	2.50±0.06 a	2.77±0.03 a	2.83±0.12 a	3.12±0.09 a
S5	10.62±0.11 a	11.01±0.12 a	11.31±0.09 a	11.96±0.09 a	6.45±0.09 a	6.82±0.12 a	7.25±0.13 a	7,90±0.14 a	0.35±0.07 a	0.80±0.05 a	1.59±0.13 a	2.13±0.08 a	2.65±0.04 a	2.88±0.07 a	3.11±0.12 a	3.30±0.09
LSD	0.712	0.745	0.60	0.64	0.56	0.42	0.58	0.612	0.03	0.24	0.28	0.61	0.52	0.44	0.49	0.52

- ***Sensory Evaluation***

Table (5) showed that the averages of scores for each organoleptic characteristic. Color, texture, appearance, taste, odor, space distribution and overall acceptability characteristics were with no significant differences among the muffins prepared. This indicates that the addition of puree did not result in undesirable changes. These results agree with work by [50]. Our finding agrees with other researches that butter has limited contribution when it comes to color and appearance of baked products [51; 52; 53]. [50] reported that high moisture in fruits or vegetables-based fat substitute plays an important role in determining the percentage of substitution. The high moisture content in muffins (with puree) was acceptable among the panelists this agrees with [50]. While [53] reported that cakes prepared with 25 or 50% fat replacers had higher mean scores for flavor and softness (moistness) than control, which go along with our results. No significant difference the control, 25% and 50% replacements in overall acceptance scores, but the 75% and 100% substitutions were significantly different. These results agree with work by [54, 55]. The 50% (S2) sample received more favorable ratings in the categories of flavor and texture. ANOVA of data ($P < 0.05$) indicated that there were significant differences amongst samples primarily in the categories of color, texture, tenderness, and overall acceptability. The differences were notable between the control and different samples. Sensory evaluation scores are summarized in Table 2. Overall data suggested that a 50%- fat and egg replacement with eggplant puree is acceptable in the muffin's formulation. The majority of significant differences detected were between the control and S5 sample. The increased replacement of fat substituted with eggs in the cake samples resulted in a reduced preference for the categories of color, texture, appearance taste and overall acceptability which deteriorated from 93 in control to 75 in sample S5. This is consistent with [56] description of the functionality of fat in baked products. A great similarity was observed in the sensory properties in each of the samples (s1 and S2 by comparing it with the control, also sample number S3 containing 50% puree, 50% eggs and fat-free had similarity with control. The last sample S5 got 75% of the total evaluation score.

Table (5) Substitution of fat and egg by eggplant puree on Sensory evaluation of muffins prepared.

Type of Muffin s cake	**Color10**	**Texture** 20	**Appearance** 20	**Taste** 20	**Odor** 10	**space distribution** 10	**Overall acceptability** 10	**Total score 100**
Control WF	9.4±0.17 [a]	19.0±0.10 [a]	18.4±0.17 [a]	18.6±0.15 [a]	9.4±0.09 [a]	9.0±0.10 [a]	9.2±0.09 [a]	93.0±0.23[a]
S1	9.4±0.15 [a]	18.8±0.13 [a]	18.2±0.15 [a]	18.4±0.11 [a]	9.4±0.07 [a]	9.0±0. 07 [a]	9.0±0.08[a]	92.0±0.19 [a]
S2	9.2±0.13 [a]	18.6±0.11 [a]	17.8±0.16 [a]	18.0±0.13 [a]	9.4±0.11 [a]	8.8±0.11[a]	8.8±0. 09[a]	90.8±0.20 [a]
S3	9.0±0.18 [a]	18.0±0.10 [a]	17.4±0.15[a]	17.4±0.12 [a]	8.8±0.10 [a]	8.4±0.10 [b]	8.4 ±0.06 [a]	87.4±0.17 [b]
S4	8.6±0.16 [b]	16.6±0.15 [b]	16.6±0.18[b]	16.4±0.14 [b]	8.4±0.08 [b]	7.6±0.08 [c]	8.0±0.11[b]	81.8±0.19[b]
S5	8.6±0.14[b]	13.4±0.13[c]	15.2±0.19[b]	14.8±0.19 [b]	8.4±0.12 [b]	7.0±0.09 [d]	6.8±0.13[c]	75.2±0.23 [c]
L.S.D	0.80	2.70	2.55	2.22	0.76	0.60	0.72	5.00

- ***Water activity***

In table (6) It was noted that free water in the zero time was in the range of 0.76 in all samples, which is an appropriate percentage suitable for storing the product for more than a month at room temperature. Then the samples began to rise in storage. The wa for the control was 0.78 after 10 days of storage, while it changed in the rest of the samples from 0.78 to 0.82, it was also noted that there was non-significant change in the statistical analysis from control to sample S2. This rise could be explained by the liberation of water molecules from binding to the dissolved fibers in the eggplant purée. By studying the pH, ph. was 4.61 at zero time, then it started to rise from 4.9 in the control to 5.13 in S5 sample, as a result of the increase in moisture loss, which led to an increase in the concentration of alkaline in the product such as fibers. Also, int table (6) by studying the effect of storage on the aw, a decrease in moisture content of the samples was observed, as it decreased in control sample from 24.6 to 23.9, and the moisture also decreased in the rest of the samples in different proportions, this decrease was due to the liberation of water from bonding with the rest of the dough components. The measurement of water activity has been shown useful for predicting the stability and safety of foods, with respect to microbial growth, deterioration reactions, and chemical and physical properties [57]. When compared with the standard, the cakes with fat substitution showed a significant difference in aw at time zero. All formulations presented critical stability over the shelf-life, since they showed values of aw exceeding 0.887, conducive to the development of some positive and negative gram bacteria and yeast [58]. These results agree with work by [59].

Table (6): Effect of storage on water activity (aW) and ph. of muffins prepared by Replacement of fat and egg by eggplant puree.

Period of storage/ Day		Room temperature		
		Moisture %	water activity (a_w)	ph
	Zero time	--	0.76	4.61
10	Control	23.91±0.10 [a]	0.78±0.02 [a]	4.90±0.06 [a]
	S1	25.74±0.15 [a]	0.78 ±0.02 [a]	4.94±0.08 [a]
	S2	27.00±0.12 [a]	0.79±0.04 [a]	5.00 ±0.05 [a]
	S3	27.75±0.14 [b]	0.80±0.06 [a]	5.12±0.07 [b]
	S4	29.71±0.11 [b]	0.81 ±0.03[b]	5.13 ±0.09 [b]
	S5	32.00±0.13 [c]	0.82±0.05 [b]	5.13±0.06 [b]
	LSD	3.51	0.021	0.13
20	Control	23.00±0.12 [a]	0.80±0.06 [a]	4.80±0.05 [a]
	S1	24.95±0.13 [a]	0.81±0.03 [a]	4.96±0.08 [a]
	S2	26.34±0.15 [a]	0.83±0.05 [a]	5.02±0.06 [a]
	S3	27.00±0.16 [b]	0.84±0.03 [b]	5.13±0.05 [b]
	S4	28.84±0.13 [b]	0.85 ±0.07 [b]	5.14 ±0.09[b]
	S5	31.20±0.11 [c]	0.86 ±0.02 [b]	5.16±0.07 [b]
	LSD	3.43	0.035	0.26
	Control	22.88±0.18 [a]	0.82±0.03 [a]	4.74±0.08 [a]
	S1	24.18±0.15 [a]	0.83±0.03 [a]	4.97±0.07 [a]
	S2	25.42±0.17 [a]	0.85±0.05 [a]	5.04±0.05 [a]

30	S3	26.24±0.14 [b]	0.86±0.08 [a]	5.17 ±0.06 [a]
	S4	28.00±0.16 [b]	0.87 ±0.06 [b]	5.18±0.05 [b]
	S5	30.31±0.15 [c]	0.88±0.04 [b]	5.20±0.07 [b]
	LSD	3.16	0.041	0.34

-Staling rate of muffins:

The results presented in Table (7) Indicated that the score of AWRC in zero time for all samples was (350,5), after storage for 10 days, it began to decrease in the control to 341.15, while in the rest of the samples it was decreasing from (340.5 to 319.40), the loss rate was 2.66 in the control, while in the rest of the samples it increased from 2.85 to 8.87. At the end of storage, after 30 days, the loss rate increased by 10% in the control, and in the rest of the samples it increased from 11.97 to 21.28. This is due to the presence of fibers in the eggplant purée, which leads to a rapid loss of water and the transition to the state of hibernation. However, by statistical analysis, it was found that there are no significant differences between the control and each of the samples S1 and S2. AS the effect of fat substitution (eggplant puree) with egg in muffins at different levels (S1, S2,S3,S4 and S5) on alkaline water retention capacity (AWRC %) of muffins from zero time up to the end of the storage time. The value of AWRC was (high freshness) in the samples which recorded (350.50) but after 30 days, the value of (AWRC %) decreased gradually in all samples (S1,S2,S3,S4 and S5) as (308.52 , 300.30, 291.75 ,283 and 275.90 period) .This may be due to the increase in water absorption content. From these data, it could be noticed that, there was gradual decrease in alkaline water retention capacity values for all different muffin's samples during storage time; these may be due to the decrease in crumb moisture during storage (as moisture migrates from crumb toward crust) as mentioned by [60]. Also [35] showed that the shelf-life of cakes depends on formulation, packaging, water activity and storage temperature. But [61] outlined that shelf-life determines the quality of industrial cakes. The shelf-life of cakes is generally from 1 to 4 weeks or more, depending on formulation, packaging, water activity and storage temperature. [62]

Table (7): Effect of storage period at room temperature on staling of muffins prepared by Replacement of fat and egg by eggplant puree.

treatment	zero time	AWRC 10 days	DR%	AWRC 20 days	DR%	AWRC 30 days	DR%
Control	350.50±0.16 [a]	341.15±0.18 [a]	2.66±0.06 [a]	329.60±0.22 [a]	5.96±0.05 [a]	315.40±0.17 [a]	10.01±0.08 [a]
S1	351.27±0.18 [a]	340.50±0.16 [a]	3.06±0.09 [a]	323.80±0.19 [a]	7.82±0.07 [a]	308.52±0.19 [a]	12.17±0.06 [a]
S2	351.83±0.14 [a]	335.00±0.21 [a]	5.06±0.07 [a]	319.90±0.17 [a]	9.07±0.04 [a]	300.30±0.16 [a]	14.64±0.09 [a]
S3	352.31±0.17 [a]	329.20±0.19 [b]	6.55±0.09 [b]	311.80±0.20 [b]	11.49±0.06 [b]	291.75±0.18 [b]	17.18±0.08 [b]
S4	352.86±0.19 [a]	324.85±0.15 [b]	7.93±0.10 [b]	305.66±0.18 [b]	13.37±0.09 [b]	283.00±0.21 [b]	19.79±0.05 [b]
S5	353.32±0.15 [a]	319.40±0.20 [b]	9.60±0.12 [c]	299.37±0.21 [c]	15.26 ±0.05 [c]	275.90 ±0.18 [b]	21.19±0.07 [b]
LSD	3.00	15.6	3.21	11.43	3.51	17.48	4.31

AWRC= alkaline water retention capacity **DR%=** Decreasing rate of AWRC

- Conclusion:

This work is an attempt to raise the economic value of eggplant by using it in some bakery products that may not affect its technological properties while reducing the energy percentage and the price of the product. By studying all the technological, sensory and chemical properties, it was found that fat can be replaced by 100% with eggplant puree, and the ability to replace eggs by 25%, as these samples gave a result similar to the control in all the properties of the tests, while the increase in the percentage of replacing eggs with eggplant puree to 50 and 75% led to a decrease In the technological properties, however, it was accepted by a large percentage up to 75 and 85% of the various laboratory tests , and therefore it is acceptable according to the taste of the consumer and from the view point of the producer

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