

# Producing Gluten - and Casein - Free Cupcakes for Children with Autism

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## Abstract

Providing appropriate foods for children with autism contributes to reducing the disorders that occur as a result of malnutrition. The study showed that fat, protein, ash, and fiber percentages were significantly higher in treatment C4. The product also gave acceptance when sensory was evaluated, and the differences were clear with different addition rates. Antioxidants and phenols have increased significantly with the high rate of addition to dates, as they contribute to eliminating free radicals within the body and thus help reduce the severity of the disorders that children suffer. Providing these foods helps provide nutrients to children and reduces diseases that affect them due to malnutrition.

## Keywords

Antioxidants, Autistic children, Gluten-free foods, yellow corn cupcakes.

## INTRODUCTION

Autism is a neurological disorder called ASDs that occurs in children of different ages. Children who suffer from this disorder have a diet that is adopted to reduce the extent of nervous disorders or spasms, as it has been noted that foods that contain gluten or casein increase their intestinal disorders, which contributed to the production or manufacture of some foods that are free of gluten or casein [1]. The current studies tended to collect a questionnaire about the disorders that affect children at different age periods, as it was noted that most of the disorders are caused by the foods consumed and the periods that affect the child's behavior [2]. Some studies have shown that children who suffer from food allergies are more susceptible to autism, as it has been noted that girls and children under the age of 12 years can develop autism, unlike boys over the age of 12 years [3]. The lack of nutrients in the foods eaten by people with autism increases their disorders, and its deficiency exposes them to other diseases, such as a deficiency of vitamins and minerals, in addition to various intestinal disorders such as constipation or diarrhea [4]. Producing bread or any pastry from gluten-free flour for people who suffer from gluten disorder or sensitivity may be unacceptable to some people. However, it can be improved by adding different types of gluten-free flour, which is rich in fiber and high in protein, contributing to Fulfilling a person's needs [5]. Some studies have shown that sensitivity to foods containing gluten and casein has helped find food alternatives for autistic children, such as yellow corn, as a partial or total substitute for wheat flour in the production of various high-value baked goods [6]. It has been proven that mixing corn flour with soybean flour increases the nutrients that contribute to the nutrition of autistic children who suffer from nutrient deficiencies on an ongoing basis. It is also possible to produce bread and

different pastries using corn flour alone or with other gluten-free flour [7]. The use of corn, rice, sweet potatoes, and some legume flour in the production of gluten-free cupcakes contributed to raising the product's nutritional value. Children with autism accepted it, as they were given some of the cupcakes produced to see how much they accepted it, even though the evaluation of its appearance was not the same. It was found in some mixtures, but when analyzed chemically, the estimates of protein, fiber, and mineral elements were high, which contributes to raising the nutritional value of the product [8]. Producing foods free of gluten and casein has become one of the most important things with the increase in autism cases. Using rice and chickpeas as a substitute for milk and producing light foods has helped provide foods that can be eaten by people with autism, as mixing more than one ingredient has contributed to raising the nutritional value by increasing the percentage of protein and fiber in addition to micronutrients such as vitamins and minerals [9].

## OBJECTIVE

The study aims to produce cupcakes for autistic children from corn flour and replace table sugar with natural honey. Date pieces were also added to the cupcake mixture to increase the antioxidants in the product. Products for autistic children can also be provided in the local markets, as these products are considered functional foods.

## MATERIALS AND METHODS

### The Prepare the Cupcake

Corn flour was purchased from local markets in Tikrit city, and dates were used after removing their seeds and cutting them into small pieces. Table (1) shows the materials and proportions of the ingredients used in preparing the cupcakes. Eggs were added to improve the consistency of the mixture,

and then corn, honey, and other dry ingredients were added to the mixture, where they were mixed manually for two minutes, after which water and vinegar were added and mixed well [10]. Date pieces were introduced to the mixture in different proportions (5, 10, 15, 20) %, and the standard treatment was considered to be the one that did not contain

date pieces. After preparing the mixture, it was poured into small trays greased with butter and then baked at a temperature of 177 °C for (15) minutes. After baking, the cupcakes were left to cool and packed in polyethylene bags for the necessary analyses.

**Table 1.** Cupcake Ingredients Proportions.

The components	C	C1	C2	C3	C4	Type, country of origin
Corn Flour	200	200	200	200	200	
Corn Oil	42	42	42	42	42	Afia - Saudi Arabia
Honey	120	120	120	120	120	Apiaries - Salah Al-Din Governorate
Salt	3	3	3	3	3	Family - Iraq
Sodium Bicarbonate	1	1	1	1	1	Iraq
Baking Powder	2	2	2	2	2	Family - Iraq
Eggs	1	1	1	1	1	Iraq
Vinegar	40	40	40	40	40	White colour - Iraq
Vanilla	2	2	2	2	2	Family - Iraq
Water	100	100	100	100	100	Tap water
Dates	-	5	10	15	20	Iraq

## Chemical Tests for Cupcakes

### Moisture Rating

The moisture content was estimated using the method [11], where 5 grams of cupcakes were placed in a convection oven at 105 °C until a constant weight was reached.

### Fat Rating

The fat content was estimated using the Soxhlet apparatus according to the method [11], where petroleum ether was used in the extraction process.

### Protein Estimation

The protein content was estimated using the method [11], where the resulting amount of nitrogen was multiplied by a factor of 6.38 to calculate the protein content.

### Ash Rating

The estimation was carried out using the standard method mentioned in [11], where 3 grams of each sample were placed in the incineration furnace at a temperature of 550 °C until a grayish-white ash was obtained.

### Carbohydrate Estimation

The percentage of carbohydrates was estimated mathematically according to the method mentioned previously [11] by the difference between the sum of the components represented by the percentage of moisture, ash, fat, and protein subtracted from 100.

### Cupcake Sensory Evaluation

Sensory evaluation of the cupcakes was conducted by 15 assessors experienced in sensory evaluation. The evaluation

was recorded according to Table 2, and the values were determined and followed up based on the pre-determined criteria [12].

### Estimation of the Antioxidant Activity

The antioxidant activity of cupcakes was evaluated using the free radical scavenging method. 1 g of cupcake samples were taken, 5 ml of methanol was added and then left for 24 h. After that, the samples were separated by centrifugation, and the resulting liquid was collected for estimation. 0.5 ml of each sample was taken, and 3 ml of DPPH solution (dissolved 0.004 mg in 100 ml of 95% methanol) was added. It was incubated for 30 min in the dark at room temperature, and the absorbance was read at a wavelength of 517 nm. The free radical inhibitory effect was calculated by comparing the absorbance with the control sample, which was prepared by adding 0.5 ml of methanol solvent to 3 ml of DPPH solution [13]. According to the following equation:

Free radical scavenging activity (%)

$$= \frac{\text{absorbance control} - \text{absorbance sample}}{\text{absorbance control}} \times 100$$

### Determination of total phenols in Cupcake

5 grams of cupcakes were taken and placed in test tubes, then 0.5 ml of 10% diluted Folin's reagent was added. The ingredients were mixed well and left for 6 minutes. After that, 1 ml of 7.5% sodium carbonate solution was added and mixed well, then the sample was left in a dark place for 2 hours. After that, the absorbance was measured at a wavelength of 765 nm, and the percentage of total phenols was calculated using the standard curve of gallic acid [14].

**RESULTS & DISCUSSION**

Table (2) shows the results of the chemical estimation of cupcakes, where significant differences were observed at the level of  $p < 0.05$  for all proportions in the components. The moisture content also showed significant differences in the averages, as the highest value was in treatment C4, which reached 7.88%, and at the same time, the standard treatment decreased by 5.05%. The increase in moisture content is due to the increase in the percentage of fibers in the treatments [15].

A chemical analysis of the cupcakes produced was carried out. It was noted in Table 2 that significant differences appeared at the  $p < 0.05$  level for all proportions in the ingredients. The moisture content showed significant differences from the averages. The highest value was in treatment C4, which amounted to 7.88%, while it decreased in the standard treatment, which amounted to 5.05. %, the increase in moisture content is due to the increase in the percentage of fiber in the treatments with the increase in the addition rate [16]. The high-fat percentage in C4 amounted to 8.33%, while it decreased in C, which amounted to 8.05%. Corn is considered high in fat percentage, as it contains a

percentage that may reach 12.3%, in addition to the fact that the mixture contains corn oil. Eggs raise the percentage of fat in the treatments. The protein content in treatment C4 increased to 5.07%, the highest among the treatments. The standard treatment recorded the lowest protein content, 3.48%. Adding eggs and dates also contributed to the increase in protein content, as dates contain a protein content of up to 2.2%. As for the percentage of ash, the differences were noticeable between the treatments, as it rose to reach the highest value of 3.59% in treatment C4, while the lowest value was recorded at 1.10% for the standard treatment. When estimating the fiber for the treatments, it increased in treatment C4 to reach 4.89% and decreased in the standard treatment to a record 2.09%. The difference in the percentage of ash results from the difference in the cupcake mixture, as adding eggs and dates gives a higher percentage of mineral elements for the treatments by increasing the percentage of dates. Dates are rich in mineral elements such as sodium, potassium, magnesium, and calcium. Table (2) shows the percentage of carbohydrates in the cupcake samples, as a significant decrease ( $P \leq 0.05$ ) is observed in the percentage of carbohydrates for samples (C, C1, C2, C3, C4) as it reached (80.23, 77.61, 74.52, 72.28, 70.24) % respectively.

**Table 2.** The chemical composition of the cupcake product

Transactions	Humidity %	Fat %	Protein %	Ash %	Fibers %	Carbohydrates %
C	5.05 e	8.05 d	3.48 e	1.10 e	2.09 e	80.23 a
C1	5.54 d	8.17 c	3.98 d	2.40 d	2.30 d	77.61 b
C2	6.32 c	8.22 cb	4.32 c	2.85 c	3.77 c	74.52 c
C3	6.77 b	8.25 b	4.88 b	b3.26	4.56 b	72.28d
C4	7.88 a	8.33 a	5.07 a	3.59 a	4.89 a	70.24 e

- is similar letters mean that there are significant differences between the coefficients
- C: The standard treatment that contains corn flour without any additives, C1: Add date pieces by 5%, C2: Add date pieces by 10%, C3: Add date pieces by 15%, C4: Add date pieces by 20%.

Table (3) shows the sensory evaluation results of the cupcake product. The results show that treatment C2 excelled in the color attribute, where it obtained the highest score of

19, while the lowest value for this attribute was in treatment C3, where it reached 16. As for the smell, the highest score was in treatment C3, which reached 19, while it decreased to 16 in treatment C1. As for the taste, the highest score was in treatment C4, where it reached 29, while the lowest value was in treatment C1, which reached 27. As for the texture attribute, it was noted that it increased in treatment C2, where it reached 29, and decreased in treatment C4 to 26. In general, there is a clear difference in the evaluation scores between the different concentrations of the cupcake product.

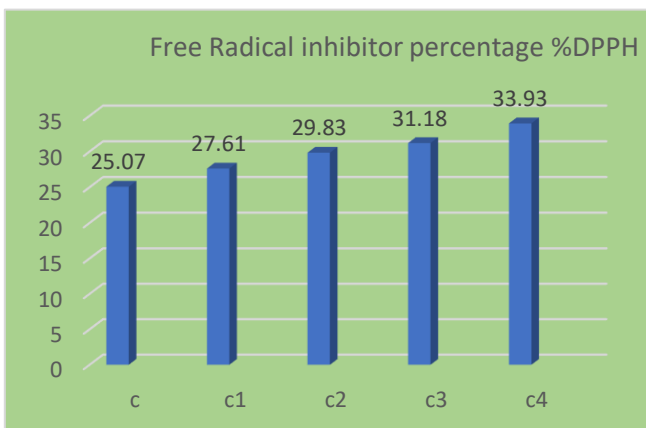
**Table 3.** Sensory evaluation results of a cupcake produced

Transactions	Colour 20	Odor 20	Taste 30	Texture 30
C	17 c	18 b	27 c	27 c
C1	18 b	16 c	27 c	28 b
C2	19 a	17 c	28 b	29 a
C3	16 d	19 a	28 b	28 b
C4	17 c	18 b	29 a	26 d

- Dissimilar letters mean that there are significant differences between the coefficients
- C: The standard treatment that contains corn flour

without any additives, C1: Add date pieces by 5%, C2: Add date pieces by 10%, C3: Add date pieces by 15%, C4: Add date pieces by 20%.

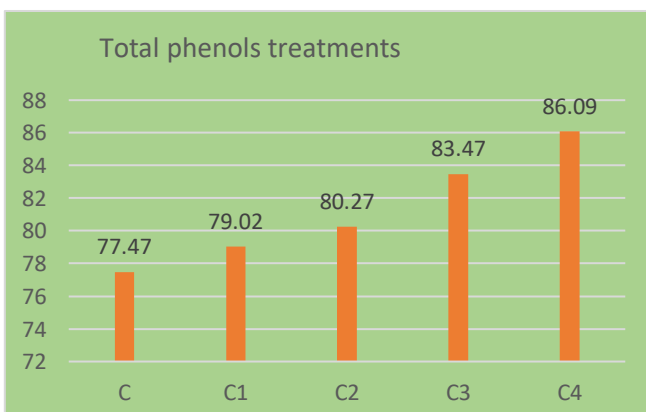
Figure (1) shows the percentage of antioxidant activity in cupcake samples at different concentrations. The data shows an increase in antioxidant activity with increasing concentration, as the concentrations (C1, C2, C3, C4) recorded percentages of (27.61%, 29.83%, 31.18%, 33.93%) respectively. At the same time, the percentage in the standard sample was 25.07%. Dates are high in natural antioxidants, and adding more dates to your cupcakes boosts the antioxidant levels in the product [17]. It is worth noting that corn also has a good number of antioxidants, thanks to its vitamins, especially vitamin A and vitamin E, which are considered to be among the most prominent natural antioxidants [18].



**Figure 1.** Percentage of antioxidant activity (DPPH) in cupcakes

- C: The standard treatment that contains corn flour without any additives. C1: Add date pieces by 5%, C2: Add date pieces by 10%, C3: Add date pieces by 15%, C4: Add date pieces by 20%.

As shown in Figure 2, the results showed a difference in the number of total phenols between treatments, where the highest amount was in treatment C4, which included adding date pieces to the cupcake, reaching 86.09 mg per 100 g. At the same time, the lowest standard content was 77.47 mg. The high phenols treatments are due to the dates containing high levels of them, as the amount reaches 40 mg per 100 g [19]. Corn also contains a group of phenols that contribute to increasing its content in the treatments [20].



**Figure 2.** Total phenolic content of cupcake product

- C: The standard treatment that contains corn flour without any additives. C1: Add date pieces by 5%, C2: Add date pieces by 10%, C3: Add date pieces by 15%, C4: Add date pieces by 20%. The total phenolic substances in the samples are mg/100g.

## CONCLUSIONS

In this study, I explored research concerning children with autism and the impact of diet on their condition. The findings suggest that certain foods can increase antioxidants in the body of children with autism. This research proposes the development of easily producible foods that appeal to all age groups. Additionally, incorporating corn flour allows individuals with gluten allergies to consume these products safely. Functional foods, as demonstrated in this study, can enhance the dietary diversity of autistic children without compromising their nutritional intake. Companies and factories, under the guidance of health and educational institutions, could play a pivotal role in producing these baked goods. Distribution of these products in schools, particularly in regions where autism prevalence is high among children, could further support their dietary needs.

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