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ORIGINAL ARTICLE

# The Effect of Jujube Fruit Flour on Physical, Chemical, Sensory and Microbial Properties of Biscuits

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ABSTRACT

**Background:** Due to the nutritional and functional qualities, jujube fruits are a good functional food to be used to augment other diets for individuals with malnutrition conditions including anemic patients, pregnant women, and children. This study evaluated the microbiological, chemical, sensory, and physical characteristics of biscuits enriched with jujube.

**Methods:** The traditional method was utilized to produce four biscuit samples with some modifications in the ratios of jujube powder, wheat flour and the addition of ground sugar, vegan butter, salt, and dry milk. The biscuits were analyzed for their physicochemical properties, sensory assessment, and microbiological analysis including total bacterial count, coliform bacteria, yeasts, and molds.

**Results:** The moisture, ash, protein, fat, carbohydrates, and energy were 9.40%, 2.43%, 5.28%, 1.648%, 1.25%, and 360.88 Kcal, respectively. The diffusion coefficient increased from 5.4% to 7.6%. A decrease in the total bacterial count from $14\times10^4$ in the control sample reached to 30, 54, and $60\times10^3$ when jujube powder was added at concentrations of 0.5, 1.5, and 3%. Mold and yeast significantly decreased with addition of jujube powder.

**Conclusion:** Textural characteristics and sensory quality of biscuits were acceptable when enriched with jujube powder. A maximum of 3% jujube powder was considered desirable to have the best quality for biscuits.

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## Introduction

The jujube (*Ziziphus jujuba*) is a member of the Rhamnaceae family of the genus Ziziphus which has over 50 species and is one of the most significant recognized species in temperate parts of the globe. As it is native to China, it is also known as Chinese jujube, Chinese dates, or poor man's fruit. Its cultivation goes back to about 4000 BC in the Mediterranean nations, and it was expanded from China through other regions in Asia, North Africa, Southern Europe, Australia, and South and North America (1, 2). It is high in essential functional components like as phenols and flavonoids. Flavonoids are a kind of chemical found in a broad range of plants. The flavonoid-rich plant extracts were shown to be beneficial in treatment of anemia (3-6). They can activate many biological activities in the body, inhibit cancer spread, decrease neuronal dysfunction, control the immune system, and lower triglycerides in the blood (7, 8).

Jujube fruits are enhanced with vitamin C, which acts as an antioxidant by inhibiting and preventing the free radical's formation. It is also used to treat chest infections, laryngeal inflammation, and pulmonary inflammation as it contains three acids of zizyberenalic, triterpenic, and ceanothenic that have a remarkable inhibitory role on activated inflammatory cells, which could be one of the main components in enhancing jujube's anti-inflammatory activity (9). Jujube is regarded as a functional food based on its high quantities of vitamins B1 and B2 and trace elements such as sucrose, glucose, fructose, free amino acids that affect the jujube taste, flavor and based on its high levels of calcium and phosphorus (10). It is used in producing of tea or processing (in recipes for sweets and jams) as well as an additive and flavoring (11).

The importance of using jujube fruits to treat chronic anemia or treat groups that suffer from malnutrition due to the high content of mineral elements in the fruits has been described before, as well as containing antioxidants, anti-inflammatory and immune-boosting materials, which makes them a good food source to support various diets have been mentioned (12). This study evaluated the microbiological, chemical, sensory, and physical characteristics of biscuits enriched with jujube.

## Materials and Methods

The jujube Ziziphus was purchased from the local Basrah market and ground in a laboratory mill, and changed into powder in concentrations of 0.5%, 1.5%, and 3%. Then it was added to biscuit mixtures containing sugar, milk powder, baking powder and salt. The study was carried out in the Department of Food Science, Basra University, Iraq. Samples of biscuits were prepared according to the method mentioned before (10) with some modification in replacement with ratios of wheat flour mixed with jujube powder (Table 1).

**Table 1:** Ingredients of laboratory-prepared biscuits.

| Raw material | Quantity per 100 g |
|---|---|
| Jujube powder | 0.5, 1.5 and 3 g |
| Wheat flour | 100 g |
| Ground sugar | 30 g |
| Vegan Butter | 20-25 g |
| Salt | 1 g |
| Dry milk | 5 g |
| Picnic powder | 4 g |
| Water | 10-25 mL |

The sensory evaluation of biscuits was conducted based on color, upper and lower layer, smell, chewing and puff, and crust thickness by an experienced and specialized assessor as previously described (13, 14) presenting distinct scores of 20 for chewiness and color and upper and lower layer, 15 for odor and puffiness, 30 for outer layer texture, and 100 for general acceptance. The study of diameter, thickness and diffusion coefficient of biscuits (D) was undertaken by taking six pieces of biscuits and evaluation from edge to edge, while thickness (T) was examined by placing six pieces of biscuits, one over the other in mm. The diffusion coefficient was determined according to the equation as explained before (15):

$$\text{Spread factor} = \frac{\text{Thickness}}{\text{Diameter}}.$$

The pH of samples was estimated using the pH-meter, by taking 5 g of the sample in 20 mL; while normalized manually with a glass stick for 3 minutes (16). Determination of total acidity was carried out employing the abrasive method by calculating the number of milli-equivalents:

$$\text{Acidity} = \frac{\text{NaOH volume} \times N \text{ of NaoH} \times 0.064}{\text{Sample weight}} \times 100.$$

Regarding microbial examination and preparation of serial dilutions, 11 g of each biscuit sample in 99 mL of a solution was prepared in a sterile condition (17, 18). Around 1 mL of each dilution was transferred into sterilized Petri dishes for microbiological counting. The nutrient agar medium was used to assess the total number of bacteria in the biscuit samples. The dishes were later incubated at 37°C for 48 hours (19). For total coliform bacterial count, 1 mL of the dilutions was transferred to sterile Petri dishes, while MacConkey agar medium was added. The dishes were further incubated at 37°C for 48 hours (20). Regarding yeasts and molds counting, malt extract agar was used after incubation at 25-27°C for 3-4 days (21).

## Results

The chemical analysis of jujube powder showed a decrease in moisture content by 9.40%, 81.25% for carbohydrates, 5.28% for protein content and 1.64% and 43%, respectively for fat and ash. A significant increase in calcium (180 mg/100 g) was noticed, while the percentages of phosphorus, potassium and sodium were 70, 820 and 42.20 mg/100 g, respectively. Also, the iron and magnesium content were 11.70 and 56.15 mg/100g, respectively. Table 2 shows the sensory characteristics of the biscuits including the smell, chewiness, color of the pulp, thickness of the crust, the color of the upper layer, the color of the lower layer and fluffiness, respectively for different concentrations of 0.50%, 1.50% and

**Table 2:** Sensory evaluation of the studied biscuits.

| T | Sample | Chewing | Spread factor | Color of lower layer | Color of upper layer | Thickness of the outer layer | Odor | Pulp color |
|---|---|---|---|---|---|---|---|---|
| 1 | Control | 7.67 | 17 | 8 | 7 | 7 | 7 | 7 |
| 2 | 0.5 | 7 | 15 | 7 | 7 | 7 | 7 | 7 |
| 3 | 1.5 | 9.33 | 17.76 | 9.33 | 12 | 9 | 8 | 9 |
| 4 | 3 | 8 | 17 | 8.5 | 8 | 8.33 | 8 | 8.33 |

**Table 3:** Physical properties of biscuits.

| Sample | Diameter | Thickness | Spread factor |
|---|---|---|---|
| Control | 40.12 | 7.1 | 5.650 |
| 0.5 | 41.31 | 6.2 | 6.66 |
| 1.5 | 42.21 | 5.5 | 7.67 |
| 3 | 38.21 | 7.0 | 5.45 |

3%. Physical properties of laboratory-made biscuits from jujube powder at concentrations of 0.5%, 1.5% and 3% were demonstrated in Table 3 revealing the concentration of 1.5% as the best concentration in terms of the diffusion coefficient (7.67).

Figure 1a shows the microbial examination for the total bacterial count, while the number in the control sample was $20\times10^4$. When jujubes were added at concentrations of 0.5%, 1.5%, and 3%, a reduction in the microbial content (78, 70 and $50\times10^3$, respectively) was observed. Figure 1b illustrates the microbial assessment for the coliform bacteria, while the number in the control sample was $14\times10^4$. When addition of jujubes was happened at concentrations of 0.5%, 1.5% and 3%, a decrease in the microbial content (60, 54 and $30\times10^3$, respectively) was visible. Findings in relation to yeast and mold counting were exhibited in Figure 1c; while the number in the control sample was $70\times10^3$. When jujubes at concentrations of 0.5%, 1.5% and 3% were added, a decline in microbial count (50, 20 and $15\times10^3$, respectively) was noted.

## Discussion

The chemical composition of ingredients added to a product is of great importance (22). The findings of the chemical composition of Jujube powder showed a decrease in moisture content by 9.40% which is within acceptable limits ≥14 to improve the storage qualities of jujube powder and reduce microbial and chemical damage (19, 23). Carbohydrate content in the studied fruit was 81.25%, which is similar to that found in the study of five types of Chinese jujube (24). The protein content was 5.28% that is higher

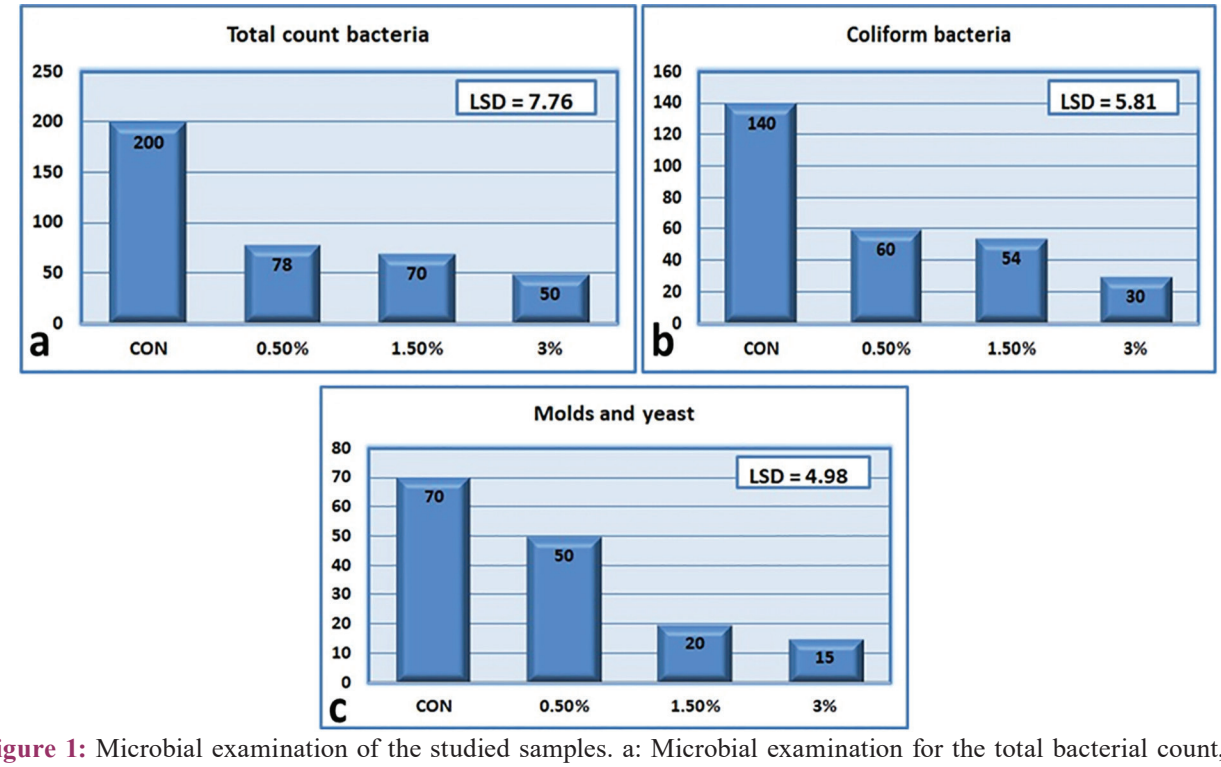


**Figure 1:** Microbial examination of the studied samples. a: Microbial examination for the total bacterial count, b: Microbial examination for the coliform bacteria, c: Microbial examination for yeasts and molds.

than a report before (25). The fat and ash values were 1.64% and%2.43 , respectively, which is lower than previous reports (26, 27). The proportion of mineral elements and the chemical composition of jujube fruits can vary, while a higher proportion of calcium content was reported in comparison to our findings (28). The results were similar regarding magnesium and iron contents when compared to Yerima and Adamu's study; while for phosphorus and sodium, they were lower and with a significant increase in potassium content (29).

The evaluation of the biscuits at different concentrations of 0.5%, 1.5%, and 3% showed significant differences for sensory evaluation of crispness, color, layer thickness, aroma, chewiness, and overall acceptability. At concentration of 3%, a significant decrease was observed in the studied attributes when compared to the control sample ($p \leq 0.05$). The jujube was shown to be high in essential functional components like phenols and flavonoids. Flavonoids are found in a broad range of plants (30). The fat and ash recorded a value of 1.64% and 43%, respectively, which is lower than a precious report (25). In our study, the powder of jujube fruits revealed a total energy ratio of 360.88 Kcal. It was shown that jujube powder has received approval as a low-calorie sweetener and is generally recognized safe (GRAS) and is allowed to be used as an ingredient in a wide range of foods and supplements (27).

The characteristic of crunchiness in biscuits is an important criterion for assessing the quality in terms of crispness and attractive appearance. Meanwhile, the color serves as a good indicator of consumer acceptance and its susceptibility to changes and storage conditions. The color of the biscuits can range from yellow to golden due to the presence of carotenoid pigments in the jujube powder, which can be affected by thermal treatments and oxidation processes during manufacturing. In our study, aroma and chewiness were deemed acceptable by evaluators at concentrations of of 1.5% and 3% of jujube powder. It was shown that the best treatment was for mixture number 3 in terms of appearance, color, chewiness, and taste, followed by treatment number 2 regarding the color, appearance, aroma, and chewiness when compared to the control sample number 1. The physical properties of biscuits illustrated that the concentration of 1.5% was the best in terms of the diffusion coefficient (7.67). This value in manufactured biscuits as the best quality in comparison to the control treatment was reported before (30). The diffusion coefficient increased from 5.4 to 7.67 due to the formation of the glutinous dough mesh due to the effect of wheat flour protein that led to an increase in the viscosity of the dough.

The statistical analysis also demonstrated a significant decrease in the bacterial number at the 1% concentration due to the presence of phenolic compounds as antioxidants. It could negatively affect Gram-positive and Gram-negative bacteria too (31, 32). The effect of jujube leaves on reduction of the total count of aerobic bacteria was shown at 5% concentration with a storage period of 14 days due to the effect of flavonoids (33). One of the antimicrobials was defined to be saponins, which causes the precipitation of proteins and some enzymes from the cell that can increase the permeability of bacterial cell membranes without destroying them based on antibacterial effect of alkaloids and their ability to interfere with DNA and interfering with cell division in both Gram-negative and Gram-positive bacteria (34, 35). In our study, a significant decrease in the bacterial count was noticed at 1% concentration that can be due to aromatic substances in jujube such as phenolic acids, flavonoids, quinones, and coumarins. It was found that the flavonoids from plant extracts possess antimicrobial and antioxidants properties (36-38).

The yeasts and molds of our research revealed a significant decrease in bacterial count at 1% concentration of jujube as its leaves contain a number of active substances to inhibit the growth of fungi, and the most important of these substances were indicated as terpenes resins, acidic materials, volatile oils, and flavones (37, 39) which are considered as antioxidants. We found the jujube to negatively affect Gram-positive and Gram-negative bacteria and reduce the total count of aerobic bacteria too. The best concentration was 5% with a storage period of 14 days due to the effect of flavonoids that was exhibited before (40).

## Conclusion

It was shown that the textural characteristics and sensory quality of biscuits were acceptable when enriched with jujube powder. A maximum of 3% jujube powder was considered desirable to have the best quality for biscuits.

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## Authors' Contribution

Faleeha and Zainab collected the samples, performed some chemical tests, analyzed, and

interpreted the results. Anwaar wrote the original draft, and Sheren reviewed the draft.

## Conflict of Interest

None declared.

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