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Research Article
Processing and Quality Evaluations of a Date-Strawberry Mixed Jam for Young Children

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Abstract

Background and Objective: Date fruits in the kingdom of Saudi Arabia are considered a staple food and play important role in the traditional and socioeconomic life of the Saudi population. Moreover, the fruits provide a wide range of essential nutrients, such as sugars, fibers, proteins and minerals. On the other hand, strawberry fruit is well known as a healthy and suitable food for young children, as it contains high concentrations of minerals, vitamins and antioxidants such as anthocyanin. Therefore, the main goal of this study was to produce a well-balanced jam with high quality and nutritional value for young children to improve their health and nutritional status, as inadequate intakes of minerals and vitamins were noticed among young children in the Kingdom and other Gulf countries. **Materials and Methods:** Date fruit was mixed as a main raw material with strawberry fruit to produce a nutritious and healthy jam. The jam product was subjected to physicochemical, color, chemical, nutritional, microbial, sensory and statistical evaluations. **Results:** The formulated date-strawberry jam partially meet the daily recommended intake of nutrients for young children. In addition, the quality characteristics of the product were found to be within the recommended specifications of jam products and were highly accepted by the panelists. **Conclusion:** The newly developed jam product could be of great help in reducing energy, mineral and vitamin deficiencies among young children, especially in the Kingdom and other Gulf countries.

Key words: Food processing, food analysis, food chemistry, nutrition, supplementation, baby food

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

The Kingdom of Saudi Arabia is one of the most important date producing countries in the world, producing approximately 1.5 million tons of date fruits per year from 31 million date trees covering approximately 108 thousand hectares[1]. On the other hand, date trees play important roles in the traditional and socioeconomic life of the Saudi population, as they are considered major sources of their income, vitality, growth and prosperity. Moreover, date fruit provides a wide range of essential nutrients, such as sugars (44-88%), fibers (6.4-11.5%), proteins (2.3-5.6%) and minerals[2,3]. Date fruits are considered one of the richest types of fruits in terms of the energy content necessary for human activity and movement.

On the other hand, strawberry fruits are usually consumed fresh or as processed food products such as jams, juices, puree and others. In fact, strawberry jam is the most popular strawberry processed product due to its attractive red color, high organoleptic properties and high anthocyanin content that acts as an antioxidant to protect the body from oxidative stress[4-7]. In fact, the available nutritional data confirmed that nutritional anemia and vitamin and mineral deficiencies remain the main nutritional challenges among children in Saudi Arabia and other Gulf countries[8].

Therefore, the main goal of this research program was to produce a well-balanced, high quality and nutritious Jam for young children using dates and strawberry fruits. Local production of food for children using local raw materials will not only save the hard currency that is usually spent on importing these food products from other countries but will also improve the health and nutritional situation of young children. Moreover, it will encourage the industrial utilization of date fruit in food production to reduce the great losses of date fruits that usually occur during handling and storage.

MATERIALS AND METHODS

Materials: Sample of sound ripe date fruits (*Phoenix dactylifera* L.) was obtained during the harvesting season (2021/2022) from the farm of the Date Palm Research Center at King Faisal University, while a fresh ripe strawberry fruit sample was purchased from a central market in Al-Hassa Governorate, Eastern Province, Kingdom of Saudi Arabia. Each fruit sample was tightly kept in polyethylene bags and stored at -18°C until needed for the different investigations.

Methods

Experimental jam processing method: The International Center for Underutilized Crops[9] stated that for the production of mixed fruit jam, the concentration of the first fruit in the jam should be more than 50% of the total fruit added. Accordingly, date fruits as the main raw material were mixed with strawberry fruits at a ratio of 2:1 for the production of mixed date-strawberry jam.

After cleaning and washing the two fruits, the date fruits (2 kg) were soaked in boiling water (1:3) for 3 hrs in a steel kettle to inactivate the enzymes responsible for browning and to make the fruits soft. The date fruit pulp was obtained by blending the soft fruits in an electric blender and filtered through a 0.58 mesh sieve to remove the date fibers, peels and seeds. On the other hand, strawberry fruits (1 kg) were blended in hot water (1 kg) and added to the date fruit pulp. After that, the required amounts of citric acid, sugar and pectin for jam processing were added based on the initial concentrations of hydrogen ions (pH value) and total soluble solids percent of the date-strawberry blend.

Then, the blend of date-strawberry with the required amount of sugar (54.04%) was placed into a steel kettle and quickly cooked until the total soluble solids percent reached 64 Brix. Then, citric acid (0.27%) and pectin (0.65%) were quickly added and mixed with continuous cooking until the Brix percentage of the blend reached 68. Finally, the hot finished product was immediately filled into dried glass jars, which were tightly closed, left to cool at room temperature and stored until needed for further investigations and the product was named as date-strawberry jam. Figure 1 and Table 1 show the processing method and the recipe used in this study for the production of date-strawberry jam products.

Physicochemical methods: The total soluble solids percent of the different samples was measured with a hand Refract Meter (No. 002603, BS eclipse, UK) as described by the AOAC[10]. Their hydrogen ion concentrations (pH) were measured by using a pH meter with two buffer solutions (pH 4.01 and 7.0) at 20°C to the nearest 0.01-pH units as reported by Ranganna[11]. The apparent viscosity in centipoises (CP) of the different samples was determined by using a Brookfield viscometer (model: Visco-Basic plus R. S/n, VBCR 110393, Fungi lab S.A, Spain) as mentioned by Quinn *et al.*[12].

Table 1: Date-strawberry jam recipe

Ingredients	Percentage
Date-strawberry total blend	45.04
Sugar	54.04
Pectin	00.65
Citric acid	00.27
Total	100.00

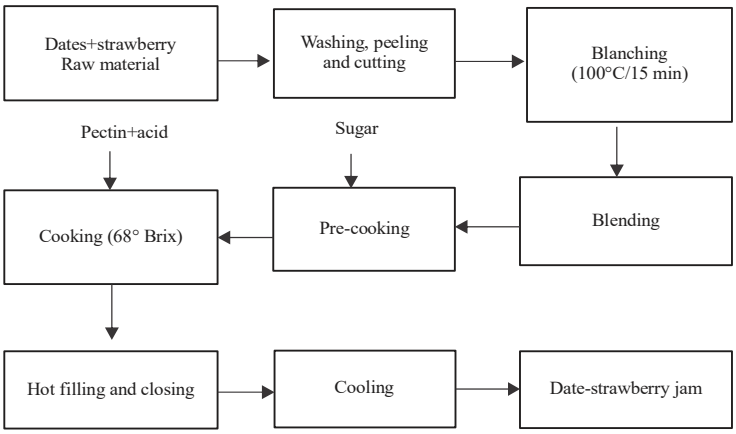

Fig. 1: Flow charts of date-strawberry jam processing steps

Table 2: Physicochemical characteristics of the date-strawberry jam

Parameter	Value
Total soluble solids (%) (TSS%)	69.01±0.0
Hydrogen ion concentration (pH)	03.30±0.01
Acidity (%) (as citric acid)	00.81±0.03
Viscosity (CP)	1860

CP: Centipoises

The color values (L*, a*, b*) of the date-strawberry jam were determined by using a Hunter Color Meter (Hunter Lab Reston Mini Scan EZ, USA) as described by Al-Jasass *et al.*[13]. The L* value is the lightness factor that gives values ranging from (0) for black to (100) for white color, while the a* value indicates the degree of greenness-redness (ranging from -60 to 0 for green color and from 0 to +60 for red color). The b* value indicates the blueness-yellowness (ranging from -60 to 0 for blue color and from 0 to +60 for yellow color).

Chemical methods: The moisture, protein, fat, ash, total sugar, reducing sugar, non-reducing sugar, vitamin C and titrated acidity concentrations in the different samples were determined in accordance with the standard methods of the AOAC[10].

Jam energy value: The energy value of the date-strawberry jam product was calculated based on Atwater factors as indicated by Leung[14].

Mineral analysis: The trace elements ferrous (Fe^{++}) and zinc (Zn) were determined according to Barnes[15] by using atomic absorbance spectroscopy (JENWAY 3110, UK). Sodium (Na) and potassium (K) were determined by using a flame photometer (model: PEP7 JENWAY). Calcium (Ca) was determined as described by Chapman and Parratt[16].

Microbial analysis: The total viable count, yeast and mold in the date-strawberry jam were evaluated by using the pour plate methods as described by Harrigan[17].

Sensory evaluation method: The jam products were sensory evaluated by using parents of young children according to the FAO/WHO[18] recommendation. The panelists were asked to evaluate the products with respect to their taste, flavor, consistency, color, appearance and overall quality, following a five-point hedonic scale ranging from 1 = dislike very much to 5 = like very much.

Statistical analysis: Data were analyzed using Statistical Analysis System (SAS) One-way analysis of variance (ANOVA) was used to compare means of sensory characteristics of date-strawberry jam samples at a 5% significance level. The mean values were tested and separated by using Minitab® (19.2020.1) software.

RESULTS AND DISCUSSION

Jam processing method: According to Kansci *et al.*[19] jam processing is considered a fruit preservation method. Jam is defined as a solid gel made by cooking fruits or vegetable pulp or their combination with sugar and pectin in the presence of citric acid. The International Center for Underutilized Crops[9] stated that the sugar concentration of the jam product should not be less than 68%. After the production of date-strawberry jam the product was immediately subjected to the following quality evaluation methods as described in Fig. 1.

Jam physicochemical characteristics: Table 2 shows the physicochemical characteristics of the date-strawberry jam

obtained in this study. The total soluble solids, hydrogen ion concentration (pH), acidity (as citric acid) and viscosity in centipoises (CP) of the date-strawberry jam were found to be 69.01%, 3.30, 0.81 and 1860 (CP), respectively. These results agree with a previous study conducted by Javanmard[20], who stated that a good jam should contain 67-70% total soluble solids with pH 3.2-3.4 and 0.3-0.8% acidity. In addition, the physio-chemical characteristics of the date-strawberry jam obtained in this study were found to be in accordance with those reported by Awulachew[21] and the ICUC[9].

In addition, Table 3 shows the results of the Hunter Lab Color Meter parameters of the date-strawberry jam expressed as L*a*b*. The date-strawberry jam sample was found to have positive values of L* (7.87), a* (31.38) and b* (13.58), classifying the product as slightly yellow with intensive red coloration. The red color of the product could be attributed to the strawberry fruit used in this study, which is very rich in anthocyanin pigment. Tsai and Huang[22] reported that anthocyanin pigments have a crucial role in the color quality of many fresh and processed fruits. In fact, jam color is not only an important quality factor for consumer acceptability but can also be considered one of the main factors that reflects the concentration of raw materials used in jam processing and their physicochemical characteristics.

Table 3: Color characteristics of the date-strawberry jam

Sample	L*	a*	b*
	----------(n=5±SD)----------		
(A)	7.87±1.9	31.38±1.30	13.58±2.05

(A): Date-strawberry jam, n: Number of independent determinations,±SD: Standard deviation, L*, a* and b* color values indicate the relative lightness/darkness, greenness/redness and yellowness/blueness, respectively

Table 4: Chemical composition and energy value of the date-strawberry jam

Chemical composition and energy value	Date-strawberry jam N = 3±SD
Moisture content (%)	25.73±0.48
Protein (%)	03.40±0.01
Fat (%)	00.81±0.01
Total sugars (%)	68.12±1.01
Reducing sugars (%)	20.80±0.46
Nonreducing sugars (%)	47.32±3.16
Ash (%)	00.57±0.01
Energy value (K. Cal./100 g)	300.59
Energy value (kJ/100 g)	1257.69

N: Number of independent determinations, SD: Standard deviation, K. Cal./100 g: Kilocalories per 100 gram. KJ/100 g: Kilojoules per 100 g

Table 5: Mineral and vitamin contents of the date-strawberry jam in comparison with their recommended daily allowance intake for young children

Minerals	Concentration (mg/100 g)	Recommended daily Allowance (mg day^{-1})*
Sodium (Na)	10.70	-
Potassium (K)	610.56	800
Calcium (Ca)	120.06	500-600
Iron (Fe)	3.21	7-10
Zinc (Zn)	1.23	3-5
Manganese (Mn)	0.8	1.2-1.5
Vitamin C (mg/100 g)	25.00	40

USA Institute of Medicine[23]

Nutritional value of the date-strawberry jam:

Chemical composition and energy value of the date-strawberry jam: Table 4 indicates the chemical composition and energy value of the date-strawberry jam product. The product had high levels of total sugars (68.12%), non-reducing sugars (47.32%) and reducing sugars (20.80%) and low levels of protein (3.40%), fat (0.81%) and ash (0.57%) on a wet basis. However, the ratio of its reducing sugar to its total sugars was 30.53%. Awulachew[21] stated that good-quality jams should have reducing sugars between 28 and 32% when compared to their total sugar content. Moreover, the product was found to provide an adequate energy value (300.59 K. Cal. per 100 g), representing approximately 23.1-16.7% of the daily energy required for children between 3 and 6 years old, ranging from 1300–1800 K. Cal./day, respectively[23].

Mineral and vitamin content: Table 5 shows the contents of minerals and vitamins of the date-strawberry jam produced in this study in comparison with the recommended daily intake of nutrients for preschool children suggested by the USA Institute of Medicine[23]. The product was found to provide appreciable amounts of potassium (610.56 mg), calcium (120.06 mg), iron (5.21 mg), zinc (1.23 mg), manganese (0.80 mg) and vitamin C (25 mg) per 100 g of jam, which represent approximately 76.32%, 20.01-24.01%, 32.1-45.86%, 24.6-41%, 53.3-66.67 and 62.5% of the recommended daily intake of nutrients for children between 3-6 ryears old, respectively[23]. The high concentration of potassium (610.56 mg) and low concentration of sodium (10.70 mg) in the jam product are useful for people suffering from hypertension[24]. These results agree with a previous study conducted by Assirey[2], who stated that date fruits have a high concentration of potassium (289.60-512.00 mg) and a low concentration of sodium (4.90-8.90 mg per 100 g of date fruit pulp).

In addition, date-strawberry mixed jam provide a sufficient amount of vitamin C (25 mg/100 g of jam), which is very important in children's food for forming collagen, cartilage, muscles, blood vessels and other connective tissues, helping to maintain capillaries, bones and teeth, healing wounds and enhancing the absorption of iron[25].

Microbial analysis of date-strawberry jam: Results showed that the jam was free from any microorganisms. This may be attributed to its high hydrogen ions concentration (3.3 pH),

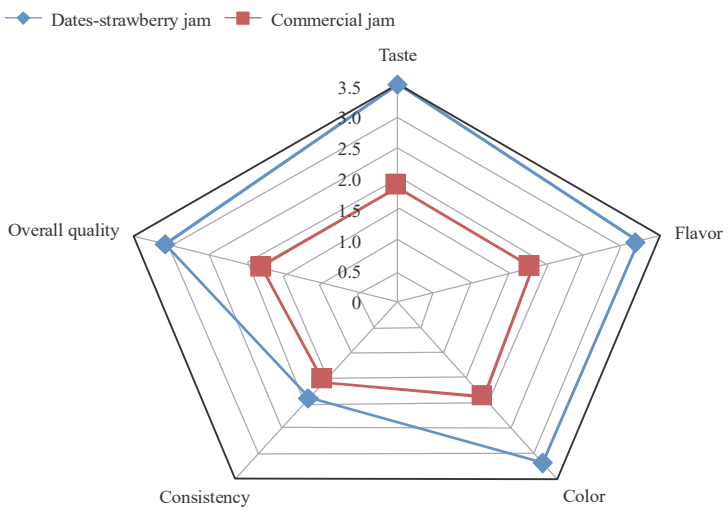

Fig. 2: Quality characteristics of the date-strawberry jam in comparison with a commercial strawberry jam product

Table 6: Quality characteristics of the date-strawberry jam in comparison with a commercial strawberry jam product

	Quality characteristics (N = 20±SD)				
Sample	Taste	Flavor	Color	Consistency	Overall quality
Date-Strawberry Jam	3.5±0.78[a]	3.2±0.93[b]	3.2±0.83[b]	1.9±0.86[b]	3.1±0.64[b]
Commercial Jam	1.9±0.95[a]	1.8±0.99[a]	1.9±0.86[a]	1.6±0.96[a]	1.8±0.80[a]
T-value	1.13	3.69	3.93	4.08	4.33
F-value	1.27	13.39	15.48	16.66	18.73
P-value	0.271	0.001	0.001	0.000	0.000

[a]Date-strawberry jam, [b]Commercial strawberry jam product, *Each value is the mean of three replicates, ±SD: Standard deviation, N: Number of independent determinations, *The same letters in the same column indicate that there is no significant difference at the $p \leq 0.05$ levels

high sugar concentration (69.01%) and high temperature (105°C) applied during jam cooking. However, the good microbial quality of the product was attributed to the good manufacturing practices that were followed during the processing steps[26].

Sensory evaluation: Table 6 and Fig. 2 show the quality characteristics of the date-strawberry jam sample produced in this study (A) in comparison with a commercial strawberry jam sample (B). The panelists confirmed that the date-strawberry jam produced in this study (A) has higher score values for all the quality attributes of jam in comparison with the commercial strawberry jam sample (B). The mean quality scores of sample (A) were 3.5, 3.2, 3.2, 1.9 and 3.1 for taste, flavor, color, consistency and overall quality, respectively. The mean quality scores of sample (B) were 1.9, 1.8, 1.9, 1.6 and 1.8 for taste, flavor, color, consistency and overall quality respectively. That is, the date-strawberry jam produced in this study (A) was found to have an attractive color and better taste, flavor, consistency, appearance and overall acceptability as compared to the commercial jam product (B).

CONCLUSION

The results obtained in this study indicate that the combination of date fruits and strawberry not only improve the nutritional and quality characteristics of the jam product but also partially allows the product to meet the daily nutrient requirements for young children. The date-strawberry jam produced in this study was free from any microorganisms. Therefore, the product could be considered a healthy breakfast food for young children (under five years old) to improve their health and nutritional status.

SIGNIFICANCE STATEMENT

This study discovered the possible industrial utilization of date fruit and strawberry for the production of jams with high quality and nutritional value, which will be of great help to improve the health and nutritional status of young children in the Kingdom and other Gulf countries. The present study will also help researchers uncover critical areas in the production of special food for young children, especially in underdeveloped countries.

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REFERENCES

1. FAOSTAT, 2019. FAO statistics. Food and Agriculture Organization, Rome, Italy.
2. Assirey, E.A.R., 2015. Nutritional composition of fruit of 10 date palm (*Phoenix dactylifera* L.) cultivars grown in Saudi Arabia. J. Taibah Univ. Sci., 9: 75-79.
3. Chao, C.T. and R.R. Krueger, 2007. The date palm (*Phoenix dactylifera* L.): Overview of biology, uses and cultivation. HortSci., 42: 1077-1082.
4. Patras, A., N.P. Brunton, S. Da Pieve and F. Butler, 2009. Impact of high pressure processing on total antioxidant activity, phenolic, ascorbic acid, anthocyanin content and colour of strawberry and blackberry purees. Innovative Food Sci. Emerg. Technol., 10: 308-313.
5. Salamon, B., V. Farkas, G. Kenesei and I. Dalmadi, 2017. Effect of added sugar and ascorbic acid on the anthocyanin content of high pressure processed strawberry juices during storage. J. Phys.: Conf. Ser., Vol. 950, 10.1088/1742-6596/950/4/042005.
6. Ertan, K., M. Türkyılmaz and M. Özkan, 2018. Effect of sweeteners on anthocyanin stability and colour properties of sour cherry and strawberry nectars during storage. J. Food Sci. Technol., 55: 4346-4355.
7. Akšić, M.F., T. Tosti, M. Sredojević, J. Milivojević, M. Meland and M. Natić, 2019. Comparison of sugar profile between leaves and fruits of blueberry and strawberry cultivars grown in organic and integrated production system. Plants, Vol. 8, 10.3390/plants8070205.
8. Nasreddine, L.M., A.N. Kassis, J.J. Ayoub, F.A. Naja and N.C. Hwalla, 2018. Nutritional status and dietary intakes of children amid the nutrition transition: The case of the eastern mediterranean region. Nutr. Res., 57: 12-27.
9. ICUC, 2004. Technical Manual for Small-Scale Fruit Processors. https://www.fao.org/fileadmin/templates/inpho/documents/AE618e.pdf
10. AOAC, 2010. Association of official analytical chemists. Official methods of analysis of AOAC International.
11. Ranganna, S., 2001. Hand Book of Analysis and Quality Control for Fruits and Vegetable Products. 7th Edn., Tata McGraw Hill, New Delhi, India pp: 594-625.
12. Quinn, M.R., L.R. Beuchat, J. Miller, C.T. Young and R.E. Worthington, 1975. Fungal fermentation of peanut flour: Effects on chemical composition and nutritive value. J. Food Sci., 40: 470-474.
13. Al-Jasass, F.M., M. Siddiq and D.S. Sogi, 2015. Antioxidants activity and color evaluation of date fruit of selected cultivars commercially available in the united states. Adv. Chem., Vol. 2015, 10.1155/2015/567203.
14. United States. Nutrition Program and W.T.W. Leung, 1968. Food Composition Table for Use in Africa: A Research Project Sponsored Jointly by U.S. Dept. of Health, Education and Welfare, Nutrition Program and Food Consumption and Planning Branch, Food and Agriculture Organization of the United Nations. U.S. Department of Health, Education and Welfare, Nutrition Program, Washington, D.C., USA, Pages: 306.
15. Barnes, K.W., 1997. Trace metal determinations in fruit, juice and juice products using an axially viewed plasma At. Spectrosc., 18: 84-101.
16. Chapman, H.D. and F.P. Pratt, 1961. Ammonium Vandate-molybdate Method for Determination of Phosphorus: Methods of Analysis for Soils, Plants and Water. 1st Edn., University of California Press, California, CA., USA., pp: 184-203.
17. Harrigan, W.F., 1998. Laboratory Methods in Food Microbiology. 3rd Edn., Academic Press, San Diego, Carlifornia, ISBN: 0-12-326043-4, pp: 36-84.
18. FAO/WHO Food Standards Programme. Codex Alimentarius Commission, 1976. Recommended International Standards for Foods for Infants and Children. FAO/WHO, Rome, Italy .
19. Kansci, G., B.B. Koubala and I.M. Lape, 2003. Effect of ripening on the composition and the suitability for jam processing of different varieties of mango (*Mangifera indica*). Afr. J. Biotechnol., 2: 301-306.
20. Javanmard, M. and J. Endan, 2010. A survey on rheological properties of fruit jams. Intl. J. Chem. Eng. Appl., 1: 31-37.
21. Awulachew, M.T., 2021. Fruit jam production. Int. J. Food Sci., Nutr. Diet., 10: 532-537.
22. Tsai, P.J. and H.P. Huang, 2004. Effect of polymerization on the antioxidant capacity of anthocyanins in roselle. Food Res. Int., 37: 313-318.
23. Institute of Medicine, Food and Nutrition Board, 2001. Dietary Reference Intakes for Vitamin A, Vitamin K. Arsenic, Boron, Chromium, Copper, Iodine, Iron, Manganese, Molybdenum, Nickel, Silicon, Vanadium and Zinc. Academic Press, Washington, DC., USA., pp: 441-502.
24. Elleuch, M., S. Besbes, O. Roiseux, C. Blecker, C. Deroanne, N.E. Drira and H. Attia, 2008. Date flesh: Chemical composition and characteristics of the dietary fibre. Food Chem., 111: 676-682.
25. JACOB, R.A., 2006. Vitamin C. In: Modern nutrition in health and disease, Shils, M.E. and M. Shike, (Eds.). Lippincott Williams & Wilkins, Philadelphia. Pages: 2069.
26. Buyukunal, S.K., G. Issa, F. Aksu and A. Vural, 2015. Microbiological quality of fresh vegetables and fruits collected from supermarkets in Istanbul, Turkey. J. Food Nutr. Sci., 3: 152-159.