

Physico-Chemical Characterization and Product Development from 5 Cultivars of *Phoenix dactylifera* L. (Date)

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Abstract. The thesis was carried out to determine the physico-chemical characteristics and to develop products from date (*Phoenix dactylifera* L.). The dates were of different varieties like Zardan, Khasab, Mariam, Barhi, Gounda and were purchased from Khulna region during August to November, 2018 and originating countries were Iran, Oman, Saudi Arabia, Tunisia. The experiment was laid out in Completely Randomized Design (CRD) with three replications. Best performance was showed by group no. 05 (cultivar: Gounda, origin country: Tunisia) in respect of the highest amount of total weight of fruit (10.925 g), seed weight of fruit (1.57 g) and weight of edible portion of fruit (9.369 g). Among the groups, highest fruit volume was (0.077 m³) and percentage of edible portion (90.848%) observed from group no. 01 (cultivar: Zardan, origin country: Iran). Highest fruit diameter (4.24 cm) found in group no. 03 (cultivar: Mariam, origin country: Saudi Arabia). The highest moisture content of fruit pulp (14.82 g/100g), vitamin C content of fruit pulp (0.99 mg/100g) and total phenol content of fruit pulp (5.144 mg/g) were observed from group no. 05. Group no. 03 showed the highest pH (6.8), TSS (10.5%). T-acidity (5.12%) showed by both 03 and 04 (cultivar: Barhi, origin country: Saudi Arabia) groups. Maximum anthocyanine 0.840 mg/100g found in group no. 04. The highest flavonoids content of fruit pulp was found in group no. 01 (8.664 g/100g). In case of development of product from date, jams were showed the highest shelf-life (15 days and 75 days) in both conditions (room temperature and refrigeration temperature) respectively. Date milk-shake was showed the lowest shelf-life (2 days and 7 days) in both conditions (room temperature and refrigeration temperature), respectively. Considering all the characteristics group no. 05 showed the best result among other groups. More studies are suggested to find out more nutritional values such as dietary fiber, ash, crude protein, carbohydrate, carotenoids, minerals and amino acids.

Key words: Physico-chemical characteristics, date, *Phoenix dactylifera* L.

Introduction

The date palm (*Phoenix dactylifera* L.) belongs to the Arecaceae (or palmae) family and consists of three parts: flesh with thin crust, date pit, and cap. The word 'Date' refers to the fleshy part of the fruit. Date, which is very sweet, comprises about 50%–88% of the total weight according to cultivar, stage of ripening, and water content. Sugars make up about two thirds of date flesh with water about one fifth. The rest of date weight includes protein, fat, crude fibre, minerals, different vitamins (especially vitamin B), tannins, and many other components (Hashempoor, 1999: 668; Robinson and William, 2012: 23; El-Hadrami and Al-Khayri, 2012; Zabar and Borowy, 2012: 39-54). Date palm tree (*Phoenix dactylifera* L.) is considered as one of the oldest and main staple and ancient crops in SouthWest Asia and North Africa. Besides, dates can be grown in Australia, Mexico, South America, southern Africa, and the United States, especially in southern California,

Arizona, and Texas (Chao and Krueger, 2007: 1077-1082; Al-Harrasi et al., 2014: 591-598; Hazzouri et al., 2015: 8824; Ashraf and Hamidi-Esfahani, 2011: 101-133).

The seed consist of a hard seed coat, endosperm and an embryo. It is oblong, ventrally grooved, with a small embryo embedded in a firm bony endosperm and covered by an operculum, (embryo cap), on the dorsal side. The seed represents about 5 to 15% of the fresh weight of the fruit. It ranges in weight from 0.5 to 4.0 gm, in length 12 -36 mm, and in the width from 6 -13 mm (Al-Bakr, 1972: 1085; Al-Qarawi et al., 2004: 176-180; Barghini et al., 2007: 1077-1082).

The top ten countries producing date are Egypt, Iran, Saudi Arabia, United Arab Emirates (U.A.E), Pakistan, Algeria, Sudan, Iraq, Oman and Libya. They produce about 91% of the world's dates (FAO, 2010). The world total number of date palms is about 120 million, distributed in 30 countries and producing between 7.51 million tons of fruit per year (FAO, 2013). Asia is the first position with 60 million date palms; while Africa is in the second position with 32.5 million date palms. Mexico and the USA have 600,000 palms followed by Europe (Spain) with 320,000 and Australia with 30,000 (Zaid, 2001: 902-915).

Date palm has a major socio-economic importance not only for its fruit but also as an ornamental plant. Because of its high nutritional value, great yields and its long life span, the Date palm has been mentioned as the "tree of life". Dates are a main income source and staple food for local populations in many countries in which they are cultivated, and have played significant roles in the economy, society, and environment of those countries (Saafi et al., 2008: 2033-2037; Chao and Krueger, 2007: 1077-1082). Date pulps hold easily digestible sugars (70%), mostly glucose, sucrose and fructose; dietary fibers and enclose less proteins and fats (Al Farsi & Lee, 2008). They also enclose vitamins like riboflavin, biotin, thiamine, ascorbic and folic acid that are essential for the body. The pulps of the fruit are rich in calcium, iron, copper, cobalt, magnesium, fluorine, manganese, phosphorus, potassium, copper, sodium, boron, sulfur, zinc and selenium (Al-Farsi and Lee, 2008: 877; Ali Mohamed and Khamis, 2004: 622-625; Elias, 2008).

Dates are a main income source and staple food for local populations in many countries in which they are cultivated. It plays momentous roles in the economy, society, and environment of those countries where they grow. Here the research work was under taken to determine the physico-chemical properties of date and prepare products from date.

Materials and Methods

The experiment on physico-chemical characterization and development of product from date (*Phoenix dactylifera L.*) was carried out during period from August to November, 2018. In the study 25 mature ripe date fruits were studied which were collected randomly from Khulna region of Bangladesh. 25 fruits were collected from markets which originated from Iran, Oman, Saudi Arabia, and Tunisia and divided into five groups according to the cultivars (Zardan, Khasab, Mariam, Barhi and Gounda). Five fruits were collected from each group. The collected fruits were brought to the laboratory of Food and Nutrition Department of K.C.C Women's College, Khulna and Environmental Biotechnology Laboratory of the Biotechnology and Genetic Engineering Discipline of Khulna University, Khulna.

Experiment 1: Study on physico-chemical characteristics of date

Experimental Design

The experiment was laid out in Completely Randomizes Design (CRD) with three replications. After collection of date they kept in ambient temperature for the study of physico-chemical characteristics. Five groups with twenty-five mature and ripe dates

were selected as the experimental materials for the investigation. List of date groups with english name, local name, cultivar, scientific name, area of collection and origin country is presented in Table 1.

Table 1. List of date groups with english name, local name, cultivar, scientific name, area of collection and origin country

Group No.	English name	Local name	Cultivar	Scientific name	Area of collection	Origin country
01	Date, Persimmon	Khajoor	Zardan	<i>Phoenix dactylifera L.</i>	Dakbangla	Iran
02	Date, Persimmon	Khajoor	Khasab	<i>Phoenix dactylifera L.</i>	Moylapota	Oman
03	Date, Persimmon	Khajoor	Mariam	<i>Phoenix dactylifera L.</i>	Dakbangla	Saudi Arabia
04	Date, Persimmon	Khajoor	Barhi	<i>Phoenix dactylifera L.</i>	NewMarket	Saudi Arabia
05	Date, Persimmon	Khajoor	Gounda	<i>Phoenix dactylifera L.</i>	NotunBazar	Tunisia

Physical Parameters

The weight of the fruit, weight of edible portion of fruit and weight of seed of fruit were taken in gram with the help of an electric balance. Diameter and volume of date were measured by a slide caliper and recorded in centimeter (cm) and meter (m³) respectively.

The percentage of edible portion of fruit (pulp) was calculated by the following

$$\text{Formula: Percentage of edible portion (\%)} = \frac{\text{Weight of edible portion}}{\text{Weight of whole fruit}} \times 100$$

Chemical Parameters

The methods for the determination of moisture content, pH, TSS, Titratable acidity, Vitamin C (Ascorbic Acid), Anthocyanin, Flavonoids and total phenol tests of fruit pulp were followed as described by AOAC (1980), Mazumdar and Majumdar (2003: 93-139), Ranganna (1979: 634), Sun et al. (2006: 98-102). The data were analyzed by fresh weight basis.

Experiment 2: Study on development of products from Date.

Experimental Materials

Mature and ripe dates were selected as the experimental materials for the development of product. These fruit were collected from different places of Khulna region.

Equipment

The experimental equipment for the processing of date products was Chula, saucepan, bottle, jar, spoon, knife, blender etc.

Period of Study

The experiment on product development of date was carried out during the period from August to November, 2018.

Development of Products from Date

In this experiment date milk-shake, date jam and date chutney were developed from date in the home.

Modified diagram of date products preparation are given below (Fig. 1, Fig. 2, Fig. 3).

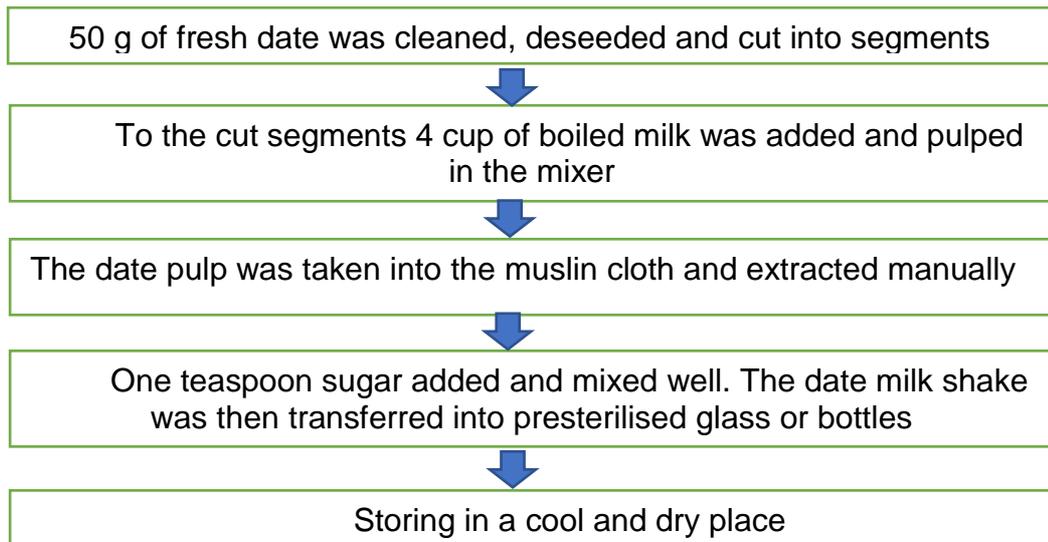


Fig. 1. Flow diagram for preparation of date milk shake

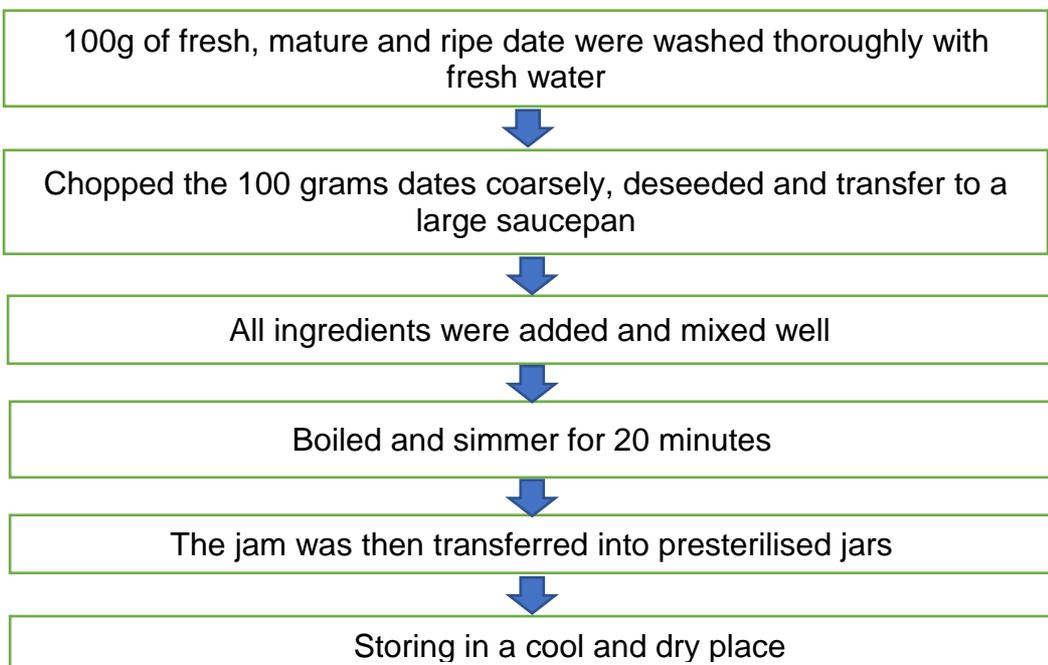
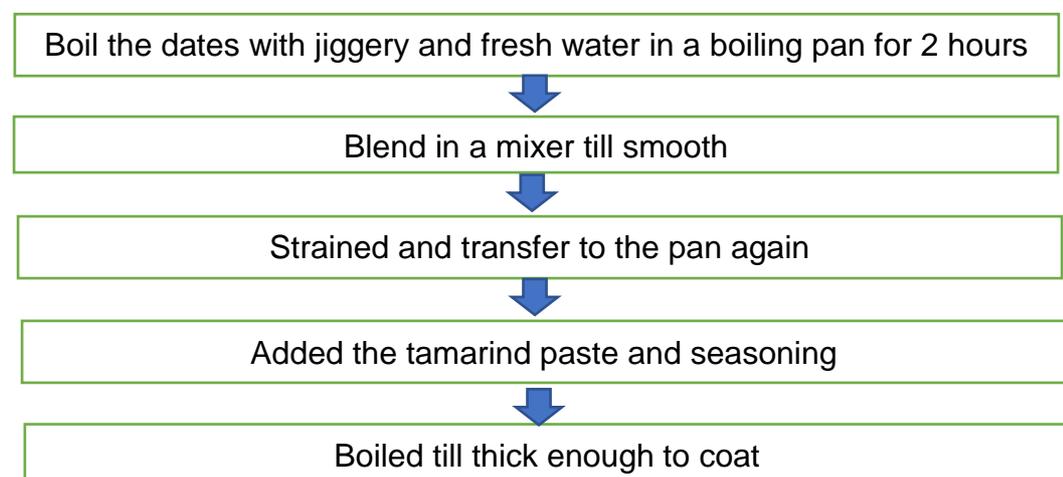


Fig. 2. Flow diagram for preparation of date jam





Cool again and store in clean airtight bottles and refrigerate

Fig. 3. Flow diagram for preparation of date chutney

Shelf Life of Developed Products during Storage

The prepared products (Date milk-shake, Date jam and Date chutney) were divided into two groups. One group of these products was kept into room temperature and another group of these products were kept into refrigerator temperature and analyzed their shelf life.

Moisture content is directly related to perishability of the products (Yahaya et al., 2015: 834-842). The high moisture content leads to a short storage life and vice versa and products will also be prone to microbial attack. By applying low temperatures mainly for preservation and extension of shelf life of fresh or processed foods, reducing the activity of microorganisms, enzymes, and chemical and biological reactions occur.

Date industries usually store temp. at -3°C up to a year. After packing and releasing to the market, the fruits are expected to have a shelf life of up to 2 years at room temperature ($\sim 25^{\circ}\text{C}$). Since quality parameters are affected by storage, it is very important to understand the effect of such storage conditions on the different characteristics and consumers' acceptability of the date fruit.

Statistical analysis

The collected data from experiment 1 & 2 were statistically analyzed by Analysis of Variance (ANOVA) method. Duncan's Multiple Range Test (DMRT) was used to compare the means of different parameters and the means were calculated by using the "MSTACTC" programme in computer.

Results and Discussion

Experiment No. 1: Study on physico-chemical characteristics of date

Physical characteristics of date

Data on physical characteristics of date are presented (Table 2). The physical characteristics of date are described based on quantitative characteristics.

Quantitative Characteristics

The quantitative characteristics of fruit which are related with weight, diameter, volume, seed weight, weight of edible portion, percentage (%) of weight of edible portion were studied.

Weight of individual fruits

The fruit weight was significantly varied among the 5 groups. The group no. 05 (cultivar: Gounda, origin country: Tunisia) was given the maximum fruit weight (10.925 g). In group no. 03, fruit weight was 10.063 g; while it was minimum in group no. 04 (5.981 g) and in group no. 01 (9.124 g) and in group no.02 (8.839g). Average fruit weight of date was found 8.986 g (Table 3).

Weight of fruit (9.124 g) from group no. 01 fairly agrees with the report of Z. Sadeghi, and K. Kuhestani (2014: 1563-1571) where they found fruit weight 9.54 g for Zardan cultivar originated from Iran.

Diameter of fruit

Significant differences were found among the 5 groups in respect of diameter of fruit. The highest diameter of fruit 4.24 was found in group no. 03. In group number 02 fruit diameter was 3.51cm while shortest fruit (2.25 cm) was measured from group 04. In

group no. 01, the diameter of fruit was 3.00cm and in the group no. 05 the fruit diameter was 3.30. Average fruit diameter of date was found 3.264 cm (Table 2).

The present study gave better fruit diameter 3.00 cm for Zardan cultivar from group no 01 than the report of Z. Sadeghi and K. Kuhestani (2014: 1563-1571) where they found fruit diameter 2.10 cm for Zardan cultivar originated from Iran.

Volume of fruit

Significant differences were found among the 5 groups in respect of volume of fruit (Table 2). The broadest fruit (0.077 m³) was found from group no. 01 which was statistically similar to the group no. 05 (0.074 m³), while shortest fruit (0.064 m³) was found in both group no. 02& 04 and statistically similar with group no. 03(0.065 m³). Average fruit volume of date found 0.069 m³ (Table 2).

The seed weight was significantly varied among the 5 groups. The group no. 05 was given the maximum seed weight (1.57 g). In group no. 03 seed weight was 1.237g; while it was minimum in group no. 04(0.742g). In group no. 01 and 02, the seed weights of fruit were 0.954 g and 0.882 g respectively. Average seed weight was found 1.077 g (Table 1).

Seed weight of fruit from group no 01 showed the similar result with the report of Z. Sadeghi and K. Kuhestani (2014: 1563-1571) where they worked on Zardan date cultivar originated from Iran.

Weight of edible portion of fruit

Significant differences were found among the 5 groups in respect of edible portion of date. It was revealed from the result that the maximum weight of edible portion (9.369 g) was found from group no. 05. The minimum weight of edible portion was 5.237 g which was found from group no. 04. In group no 01, 02 and 03, the weight of edible portion of date were 8.089 g, 7.968 g and 8.852 g respectively. Average weight of edible portion of date was found 7.903 g (Table 2).

Percentage (%) weight of edible portion of fruit

Significant differences were found among the 5 groups in respect of percentage of weight of edible portion of date. The result showed that the highest percentage of weight of edible portion (90.848%) was found in group no. 01 and the lowest percentage was measured from group no. 05(85.761%). In group no. 02 percentage was measured 90.148%. In group no. 03 and 04, the percentages of weight of edible portion of fruits were 88.144% and 87.569% respectively. Average percentage of weight of edible portion of fruits was 88.494%.

Table 2. Physical characteristics of date (*Phoenix dactylifera L.*)

S L.	Collection Area	Group No	No of Fruit	Fruit Weight (g)	Fruit Diameter (cm)	Fruit Volume (m ³)	Seed Weight (g)	Weight of edible portion (g)	Edible portion (%)
1	Dakbangla	01	5	9.124c	3.00c	0.077a	0.954c	8.089b	90.848a
2	Moylapota	02	5	8.839d	3.51b	0.064b	0.882cd	7.968bc	90.148b
3	Dakbangla	03	5	10.063b	4.24a	0.065bc	1.237ab	8.852b	88.144bc
4	New Market	04	5	5.981e	2.25d	0.064b	0.742d	5.237c	87.569c
5	Notun Bazar	05	5	10.925a	3.30bc	0.074a	1.57a	9.369a	85.761d
Average				8.986	3.264	0.069	1.077	7.903	88.494
Level of significance				0.05	0.05	0.05	0.05	0.05	0.05
C.V%				20.812	22.158	8.820	30.581	20.203	2.310

Note: In a column figures having similar letters do not differ significantly whereas figures having dissimilar letters differ significantly as per DMRT.

Table 3. Chemical characteristics of date (*Phoenix dactylifera L.*)

SL	Collection Area	Group No.	No. Of fruit	Moisture Content (g/100g)	pH	TSS (% Brix)	T-acidity(%)	Vitamin C (mg/100g)	Anthocyanin (mg/100g)	Flavonoids (g/100g)	Total phenol (mg/g dry extract)
1	Dak-bangla	01	5	12.82bc	6.1cd	10.2b	4.12b	0.35c	0.426d	8.664a	4.866b
2	Moyla-pota	02	5	11.92c	5.8d	10.00c	3.84c	0.39c	0.801b	8.104ab	2.288d
3	Dak-bangla	03	5	13.65b	6.8a	10.5a	5.12a	0.75b	0.616c	8.341b	3.309c
4	New Market	04	5	13.89b	6.5c	10.1bc	5.12a	0.24d	0.840a	8.197ab	2.659cd
5	Notun Bazar	05	5	14.82a	6.7b	10.00c	4.12b	0.99a	0.606c	7.837c	5.144a
Average				13.421	6.38	10.16	4.464	0.544	0.657	8.228	3.653
Level of significance				0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
C.V %				8.203	6.594	2.040	13.657	57.774	25.422	3.706	35.331

Note: In a column figures having similar letters do not differ significantly whereas figures having dissimilar letters differ significantly as per DMRT.

Chemical characteristics of date

Moisture content of fruit pulp

There were significant variations among the five (05) groups in respect of moisture content of fruit pulp. The highest moisture content of fruit was found in group no.05 (14.82 g/100g) and the lowest content of fruit pulp was found in group no. 02 (11.92 g/100g). From group no. 01, 03 and 04, the moisture content was 12.82g/100g, 13.65 g/100g and 13.89 g/100g respectively. Average moisture content of fruit pulp of date was 13.421g/100g (Table 3).

Similar result in respect of moisture of fruit pulp in the case of date obtained by Al-Farsi and Lee (2008: 877) were worked on nutritional and functional properties of dates.

pH of fruit pulp

There were significant variations among the five (5) groups in respect of pH of fruit pulp. The highest pH of fruit was found in group no. 03 (6.8) and the lowest pH content of fruit pulp was found in group no.02 (5.8). In group no. 01, 04 and 05, the pH content was 6.1, 6.5 and 6.7 respectively. Average pH of fruit pulp of date was 6.38 (Table 3).

The present study fairly agrees with the Sultana Parvin et al. (2015: 274-278). The present study found 6.7 pH from group no 05 where they found pH 6.3 which statistically similar.

Total Soluble Solids (% Brix) content of fruit pulp

The differences of Total Soluble Solids were significant among the 5 groups. The highest percentage of TSS was observed from group no. 03 (10.5%). The lowest

percentage of TSS was observed from group no. 02 (10.00%) which was statistically similar with group no. 05(10.00%). 10.2% and 10.1% of Total Soluble Solids (% Brix) were found in group no. 01 and 04 respectively. Average Total Soluble Solids content was 10.16% (Table 3).

Titrateable acidity content of fruit pulp

The Titrateable acidity (T-acidity) showed significant variation among the 5 groups. The highest content of Titrateable acid was found in group no. 03 (5.12%) which was statistically similar with group no. 04 (5.12%). The lowest percentage of Titrateable acid content was found group no. 02 (3.84%). In group no. 01, the Titrateable acid content was found 4.12% which was statistically similar with group no. 05 (4.12%). Average Titrateable acid content was 4.464% (Table 3).

Vitamin C (Ascorbic acid) content of fruit pulp

There was significantly variation among the 5 groups in respect of vitamin C (Ascorbic acid) content of fruit pulp. The highest vitamin C content of fruit pulp was found in group no. 05 (0.99 mg/100g) and the lowest vitamin C content of fruit pulp was found in group no. 04 (0.24 mg/100g). In group no. 01, vitamin C content of fruit pulp was observed 0.35 mg/100g which was statistically similar with group no. 02 (0.39 mg/100g). 0.75 mg/100g of vitamin C content was found in group no. 03. Average vitamin C content of date was 0.544 mg/100g (Table 3).

Anthocyanine content of fruit pulp

The differences of Anthocyanine content of fruit pulp were significant among the 5 groups. The highest Anthocyanine content of fruit pulp was found in group no. 04 (0.840 mg/100g) and the lowest Anthocyanine content of fruit pulp was found in group no. 01 (0.426 mg/100g). In group no. 03, Anthocyanine content of fruit pulp was observed 0.616 mg/100g which was statistically similar with group no. 05 (0.606 mg/100g). In group no. 02 Anthocyanine content of fruit pulp was observed 0.801 mg/100g. Average anthocyanin content of fruit was 0.657 mg/100g (Table 3).

Flavonoids content of fruit pulp

There was significantly variation among the 5 groups in respect of flavonoids of fruit pulp. The highest flavonoids content was observed from group no. 01 (8.664 g/100g) and the lowest content of flavonoids was found in group no. 05 (7.837 g/100g). In group no.02 flavonoids content of fruit pulp 8.104 g/100g which was statistically similar with group no. 04 (8.197 g/100g). In group no.03, the flavonoids content of fruit pulp was 8.341 g/100g. Average flavonoids content of fruit was 8.228 g/100g (Table 3).

Total phenol content of fruit pulp

The differences of Total phenol content of fruit pulp were significant among the 5 groups. The maximum phenol content was found in group no. 05 (5.144 mg/g). In group no. 01 phenol content was observed 4.866 mg/g. The minimum phenol content was found in group no. 02 (2.288 mg/g). 3.309 mg/g and 2.659mg/g, phenol content of fruit pulp was found in group no. 03 and 04. Average content of phenol from fruit pulp was 3.653 mg/g (Table 3).

Experiment No. 2 Study on Development of Product from Date

Product development from date and determine the shelf-life during storage

Three products (Date milk-shake, Date jam, Date chutney) were made in the home and observed their shelf life during storage (refrigerator and room temperature).

Refrigerator temperature

Refrigerator temperature means storage at temperatures above freezing of water in the foods usually in the range of 16°C to -2.2°C. Refrigerators usually operate at 4°C to 7°C.

Room temperature

Room temperature is a comfortable temperature range of indoors, usually considered to be 20°C to 25°C.

Shelf life during storage of developed date product:

1) Date milk-shake

Stored of developed products were found that the duration of shelf life of date milk-shake in room temperature and refrigerator temperature 2 days and 7 days respectively (Table 3).

2) Date jam

Duration of shelf life of date jam in room temperature and refrigerator temperature 15 days and 75 days respectively (Table 4).

3) Date chutney

Duration of shelf life of date chutney in both room temperature and refrigerator temperature 5 days and 30 days respectively (Table 4).

Table 4. Shelf life during storage of developed date product

SL No.	Shelf life duration (days) during storage	Date milk-shake	Date jam	Date chutney
1	Refrigerator temperature	07a	75a	30a
2	Room temperature	02b	15b	05b
	Average	4.5	45	17.5
	C.V%	127.279	106.066	98.994

Conclusion

Considering all the characteristics group no.05 (cultivar: Gounda, origin country: Tunisia) showed the best result among other groups. Further trial is needed on other characteristics of the groups like dietary fiber, ash, crude protein, carbohydrate, carotenoids, minerals and amino acids, vitamin A content, total sugar content, annual production and determine the growth of various microorganisms into date.

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