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Changes in Physical and Chemical Characteristic of Mozafati Date Fruit During Development

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Abstract: Chemical and physical characteristic of Mozafati date fruits, the main date cultivar which widely consumed in Iran, were studied at different stages during development (kimri, khalal, rutab and tamr). All the fruits were green at the kimri stage and then turned red and black at the khalal and rutab stage, respectively. The length, width and volume increased as the fruits developed and reached highest at the khalal stage. Fruit weight increased rapidly at the kimri stage and then started to decrease during ripening. Results showed that moisture content and tannins decreased from kimri to tamr, but Total Soluble Solids (TSS) and reducing sugars increased. Mozafati date had a high reducing sugar in ripe fruit. There was no difference in total soluble solids of fruits at rutab and tamr stage. Green dates had a moisture content of 81.2-83.5% which decreased to 26-30% at rutab stage. The high sugar content and also moisture content around 30% at rutab stage rendered the date extremely sensitive to microorganisms infection such as yeasts and molds after harvest. The pH was low at kimri stage (5.7) and then increased around 7 at rutab stage. Mozafati rutab will not mature further into tamr on the palm and tends to drop before reaching tamr stage.

Key words: Mozafati date fruit, ripening stage, chemical, physical characteristic

INTRODUCTION

Date fruit (*Phoenix dactylifera* L.) is an agricultural product of Iran. Cultivar Mozafati date is considered the main cultivar in Kerman province, has been a staple food for the general masses of the people. Dates mature through various stages which each of them distinguished by one or more particular physio-chemical characteristics. The first stage, kimri, is an inedible green fruit which then develops into khalal and rutab stages. At khalal, dates begin to lose moisture and in parallel accumulate considerable quantities of sugar. At rutab, loss of moisture is accelerated and the fruit becomes softer in texture. At the final stage, tamr, the fruits contain the least amount of moisture and maintain a soft texture and a sweet taste^[1,2]. Results of experiments showed consistent trends in the changes that occurred in the chemical composition of different date cultivars through a number of distinct phases of date fruit development^[3,4]. The results showed that moisture, acidity and tannins continued to decrease as the fruit developed from kimri to rutab with a minimum content in tamr. On the other hand, total sugars and reducing sugars continued to increase from one stage to the next. Boojj *et al.*^[5] studied composition of 5 date palm cultivars (Bou Skri, Deglet Nour, Mejhool, Thoory and Zahidi) at different

stages of maturity. Deglet Nour had a high sucrose content in ripe fruit and Mejhool date was rich in amino acids at the unripe stage^[7]. Proteins from some date cultivars were also investigated by Ahmed *et al.*^[6]. The studies showed that early green dates contained very little protein. There was a rapid increase in the protein content and also in the number of protein components at a later stage in maturation. Recently, Elmardi *et al.*^[5] reported that pollination method affects on the physical and chemical characteristics of date fruits. They concluded that hand duster produced more fruits per strand than the motorized duster and the hand pollination method. The aim of this study was to investigate effect of ripening stage on chemical and physical properties of Mozafati date fruit.

MATERIALS AND METHODS

Cultivar Mozafati, which is considered the main date cultivar in the packing industry of Kerman was selected for this experiment during 2003 season. Medium height palms in Shahdad were randomly selected and pollinated by hand in April. In the beginning of kimri stage, date fruits were harvested at weekly intervals from the experimental station in Shahdad. Samples were immediately placed on ice until processing.

Physical characteristics assessed were date and pit weight, date length, date width and fruit volume. Chemical characteristics determined were Total Soluble Solids (TSS), reducing sugar content, moisture content, tannin content, pH and acidity level. These factors were determined according to AOAC^[7] and Leonard *et al.*^[8]. Moisture content was determined by distillation method in which a solvent immiscible with water is codistilled from a weighed sample. The solvent (Toluene) has a boiling point slightly higher than that of water. Upon boiling, the solvent and water distill over, are condensed, and drop into a graduated collection tube. Determination of pH was performed with pH meter (Metrohm, 691 pH meter). The acidity was determined by titration of samples with 0.1 N. Sodium hydroxide and expressed in g acid (Malic acid) per 100 g product. A hand refractometer (Carl Zeiss, Germany) was used to determine total soluble solids. The chemical determination of the reducing sugars were based on the property of these sugars of reducing copper in the cupric state to cuprous oxide. The Fehling method was performed for reducing sugar determination. The method for determination of tannin content in date samples was titration in which Indigo Carmine was used as reagent. Volume of fruits was determined by water displacement. Data were statistically analyzed in a Randomized Complete Block Design and analysis of variance was done with LSD values to compare the means.

RESULTS AND DISCUSSION

Mozafati date fruits were green at the kimri stage, but after reaching the khalal stage, they attained a red colour. The fruits were black, soft and ellipsoidal to oblong in shape at the rutab stage. They consume in great quantity as rutab in Iran. The statistical analysis of data indicated that there is significance difference ($\alpha = 1\%$) among the physical characteristics of fruits during various stages of development. It can be seen from Fig. 1 that there was a rapid increase in weight and volume of fruits at the kimri stage. The length and width also increased as the fruits developed and reached highest after 16 weeks of pollination. At the end of this period (khalal stage), weight started to decrease. However, according to variety, growth condition and development stages, date fruits vary in shape, size, weight and other morphological properties^[9]. Ashour Ahmed^[10] also reported physico-chemical properties of 24 date varieties from 3 regions in Libya and concluded that there is no significance difference among the length of dates of the three regions, although the significance difference was clear among the date varieties within the region.

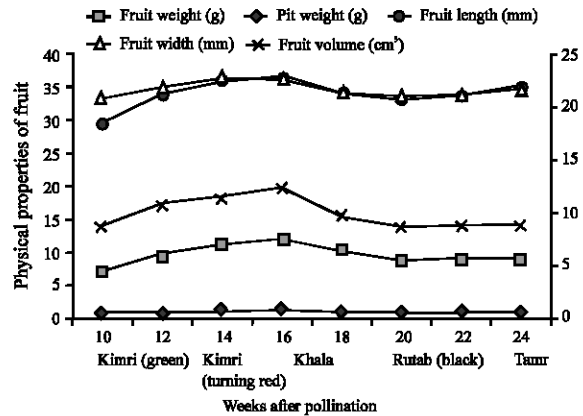


Fig. 1: Morphological changes in Mozafati date during development stages

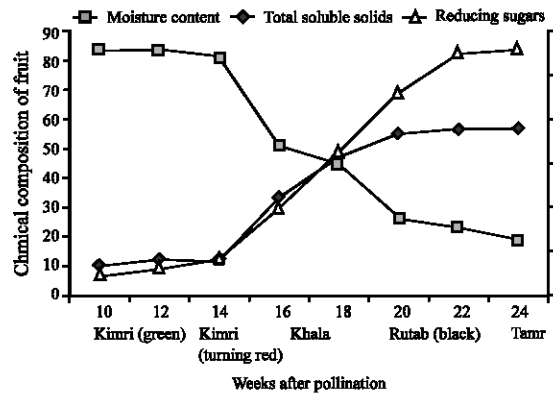


Fig. 2: Compositional changes in Mozafati date during development stages

As fruits matured from kimri to tamr, their chemical composition changed considerably. The chemical properties of dates are considered important factor in grading, preservation, storage and processing of dates. Moisture content decreased during ripening. At the kimri stage, the fruits had a moisture content of 81.2-83.5%, which decreased to 45-50.4% at khalal. Moisture content decreased further at rutab stage to 26% (Fig. 2). However, a decrease in moisture content during fruit development observed in our experiments resembles results obtained by Ahmed *et al.*^[6] and Al-Hooti *et al.*^[11].

Figure 2 shows that moisture content decreased progressively from kimri to tamr, but total soluble solids and reducing sugars increased. Total soluble solids and reducing sugars increased slowly during 14 weeks after pollination and there was a rapid increase in them at the khalal stage. Total soluble solids in the fruits do not appreciably differ in quantity at rutab and tamr stage. Changes in physico-chemical properties of dates during the development has also been stated by Barreveld^[1].

Table 1: Averages of pH, acidity and tannin content of date fruits during maturation

FF	Weeks after pollination							
	Kimri		Kimri (turning to red)		Khalal		Rutab Tamr	
	10	12	14	16	18	20	22	24
pH	6.54	5.7	6.42	7.31	7.6	7.46	7.32	7.58
Acidity percent (as malic acid)	0.31	0.40	0.31	0.34	0.35	0.43	0.49	0.40
Tannin content (%)	1.3	1.13	0.94	0.64	0.55	0.40	0.24	0.23

Table 2: Physico-chemical characteristics of Mozafati date fruits at the harvest period (Averages)

Variety	Date weight (gr)	Date length (mm)	Date width (mm)	Date volume (cm ³)	Acidity (as malic acid) pH	Moisture (%)	TSS (%)	Reducing sugar (%)
Mozafati rutab	10.2	34	21	8.6	6.9	0.43	28	65

According to him, kimri stage was the period of highest acid activity and moisture content while at the khalal stage, sucrose content increased but moisture content decreased. Fruits at kimri stage, had the lowest pH 5.7 which then increased through the developmental stages and reached to 7.6 at the end of khalal stage (Table 1). The green dates (kimri) were significantly astringent and had a tannin content of 1.3%. At the khalal stage, tannins started to precipitate and lose their astringency. However, there was a decrease in tannins during fruit development^[11]. Similar results have also reported by Al-Hooti *et al.*^[11] and Barreveld^[1]. Dates contain a layer of tannin, a little below the skin of the drupe which is associated with the sensation of astringency. Tannins in date fruits are made mainly of polyphenols and in lesser amounts of flavone.

Mozafati date fruits are harvested in the rutab stage, when they have about 26-30% moisture content and 55-65% sugar content depending on region. These will not mature further into tamr on the palm and tends to drop before reaching tamr stage. The way of converting rutab is sun curing and drying which is still practiced in Bam area of Iran. Mozafati date fruits do not ripen simultaneously, neither on one particular bunch, nor on different bunches of the same palm. The time lapse between the first date to reach maturity and the last one on one palm may last 3 to 5 weeks. In Bam, Mozafati date fruits pick as many as three to five times a season. Table 2 shows that Mozafati rutab has high moisture content and must be considered perishable. Therefore, the dates in a warm moist atmosphere are attacked by microorganisms (especially yeasts and molds) and

fermentation or souring will occur. Apart from microbial attack, increasing moisture content also trends to increase biochemical processes in the dates^[1]. Therefore, immediately after harvest, they should be transported and stored in refrigerated condition to prolong their storage life by stopping or retarding biochemical and biological processes. Thus, enzymatic reactions slow down as well as the activity of microbial and insect life. In Iran, the conventional method of rutab conservation after harvest is cold storage at -5°C. This is the most suitable method, but it is energy consuming. Mozafati rutab, which is soft fruit date cultivar, contains about 52% reducing sugars and little sucrose. Generally, soft date cultivars contain mainly glucose and fructose, whereas date cultivars with a firm and dry texture contain a high percentage of sucrose. In soft date cultivars, which contain high amounts of reducing sugars in the ripe fruits, non enzymatic browning induces development of a caramel like taste^[12].

From the data reported here, significant differences in the physical and chemical characteristics were observed during development stages. However, our observations indicated maximum moisture and tannins in green dates. During maturation, tannins and moisture content decreased and in parallel sugar content increased. The moisture content around 30% at rutab stage will facilitate spoilage of Mozafati rutab.

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