World Journal of Dairy & Food Sciences 1 (1): 28-32, 2006
ISSN 1817-308X

A Study on the Physico-Chemical Properties of Iranian Shamsaei Date at Different Stages of Maturity

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Abstract: Physico-chemical properties of the Iranian date variety Shamsaei were examined at progressive levels of maturity. Fruit samples were collected during kimri, khalal, rutab and tamr stages by weekly intervals. Chemical and physical characteristics were determined using published procedures. The dates had the longer dimensions and heavier weights at the khalal stage. The tannin content and moisture content decreased as the date matured, but total soluble solids and reducing sugars increased. Green dates had a moisture content of 81.33-81.77% which decreased to about 15% at tamr stage.The dates had the highest total soluble solids and reducing sugars owing to moisture loss at the tamr stage.The content of reducing sugars increased slowly during 14 weeks after pollination. There was a rapid increase in reducing sugars at the khalal stage and their content reached to about 61% at the tamr stage. The high sugar content and low moisture content at tamr stage rendered Shamsaei date extremely resistant to microbial spoilage after harvest. The tannin content of green dates was about 1.7% which decreased around 0.24% at the tamr stage. The results showed that pH increased during maturation 2and reached about 7 at tamr stage. Shamsaei dates will mature into tamr on the palm and harvested as semi-dry when their sugar content is about 60%.

Key words: Shamsaei date fruit · ripening stage · semi dry date

INTRODUCTION

Date palm is one of the major agricultural crops of the Near East region, where about 90% of the world dates production take place [1]. In many countries in this region, the date palm plays an important economical and sociological role. Iran is considered one of the largest producers of date with production about 1000, 000 tons which is about 15% of total world production. About 400 varieties are grown in Iran, among these with good taste and sweetness is Shamsaei. This variety is the most important variety of semi dry date in Shahdad region of Kerman province, Iran. Date fruits are called Porku at the rutab stage and can be consumed at this stage but they usually ripen perfectly upon the tree and harvested at the tamr stage. To harvest the Shamsaei dates, the climber will climb unaided, carrying a rope with him with which will support himself when he reaches the top. Then the bunches are cut and lowered down to the ground. However, the dates are considered high energy foods containing sugars and fiber thus being suitable for people. To come to this stage, they pass through several separate stages of maturity, traditionally described by changes in color, texture and taste/flavour. The differences in these stages have been attributed to changes in chemical composition [2]. The chemical composition of dates is related to textural properties and mouthfeel at various stages of maturity. Green dates (Arabic kimri) contain maximum moisture and tannin and are firm in texture. At the kimri stage, there is a rapid increase in size, weight and reducing sugars. Then, the inedible green fruit develops into khalal and rutab stages. At the khalal stage, sucrose content increases and moisture content begins to decrease. The tannins will also precipitate and lose their astringency. At the third stage (Arabic rutab), there is a decrease in weight due to moisture loss and inversion of sucrose into invert sugar and a browning of the skin and softening of the texture. When the dates are left on the palm they will turn into tamr at which they have the east amount of moisture and tannin and are self-preserving [2-5]. Results of several investigations showed changes that occurred in the chemical composition of different date cultivars during maturation. As dates mature, their texture become soft which is associated with progressive changes in the fruit fiber. Mustafa *et al.* [6] reported that the pectin content of

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dates increased on a fresh weight basis during maturation. Dates contain tannins which are made mainly of polyphenols and thought two groups of them (phenolic acids and condensed tannins) to be important in producing the astringent sensory response [2]. The tannins are responsible for astringency of dates and according to Sawaya *et al.* [3], their content decreased as maturity progressed. There is a relationship between the sweetness of dates and the amount of sugar which increases gradually during maturation. Booij *et al.* [7] found that Deglet Nour dates had a high sucrose content in ripe fruit. Results of other experiments showed that total sugars and reducing sugars continued to increase from one stage to the next. Sucrose increased in the case of dry dates and decreased in soft dates. Moisture content, acidity, pectin and tannin also decreased as the fruit developed from kimri to khalal to rutab with a minimum content in tamr. Al-Hooti *et al.* [8] reported that date cultivars of Shahla, Gash Gaafar, Gash Habash, Lulu and Bushibal had a considerable amount of some important minerals such as Ca, Mg, P, K, Fe, Cu and Zn. However, the high nutritional status of dates is due to the considerable quantity of ash or the appropriate mineral balance. Generally date fruits are deficent in protein and fat. Early green dates contain very little protein which will increase at a later stage in maturation. A study of physico-chemical properties was conducted on 24 dates in three regions of Libya by Ahmed [1]. The results showed that the middle region varieties had the lowest moisture content with comparison to the coastal and south region varieties. There was also no significant differences ($p<0.05$) in the content of both protein and fat among the dates of different regions. However, chemical composition provides useful information about fruit physiology. The present experiment was intended to study some characteristics of Shamsaei date fruit at different stages of maturity.

MATERIALS AND METHODS

Date samples: From June to October 2003, dates of Shamsaei variety were harvested by weekly intervals from the Agricultural Research Center Experimental Station in Shahdad region of Kerman province, Iran. The fruits were immediately packaged in plastic bags and placed on ice until chemical analysis.

Physical and chemical analysis: Physical characteristics assessed were date and pit weight, date length, date width and fruit volume. Volume of fruits was determined by water displacement as described by El-Mardi *et al.* [9]. Chemical characteristics determined were Total Soluble Solids (TSS), reducing sugar content, moisture content, tannin content, pH and percent acidity. These factors were determined using published procedures [10, 11]. Samples (25 g) of pitted dates from the weekly interval harvests were mixed with 100 mL of distilled water in a small food mincer and then filtered through a paper filter. The solution was used to determine chemical properties of the samples. A hand refractometer (Model Carl Zeiss, Germany) was used to determine total soluble solids. A drop of the solution was poured on the inner face of the cover of the refractometer and pressed the cover firmly against the glass prism. Then, the percentage of solids in the sample was read. Chemical determination of the reducing sugars were based on the property of these sugars to reduce copper in the cupric state to cuprous oxide. Under specified conditions, the amount of reduced copper is a measure for the quantity of reducing sugars. The fehling method was performed for reducing sugar determination. 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 collected into a graduated collection tube. The method for determination of tannin content in date samples was titration in which Indigo Carmine was used as reagent. Determination of pH was performed with pH meter (Model Metrohm, 691 pH meter). The pH meter measured the electrical potential between the hydrogen ions in the solution and a standard electrode. The acidity was determined by titration of samples with 0.1 N sodium hydroxide and expressed in gram acid (Malic acid) per 100 g product. Data were statistically analyzed in a Randomized Complete Block Design. Differences between means were determined by calculating least significant difference after analysis of variance.

RESULTS AND DISCUSSION

Physical properties: Shamsaei date fruits were green at the kimri stage, but attained a yellow color at the khalal stage. The fruits were semi dry, egg shaped and brown in color at the tamr stage. The mean scores for the physical characteristics of the dates are presented in Table1. Physical properties of the dates were maximum at the khalal stage (16 weeks after pollination). Pit weight was 0.79 g at the kimri stage and gradually increased to a maximum of 1.08 g at the khalal stage.

Table 1: Mean scores for the physical characteristics of Shamsaei dates during development stages

	Weeks after pollination							
Property	10	12	14	16	18	20	22	24
Fruit length (mm)	26.00b	28.67ab	29.33ab	31.00a	29.67a	28.33ab	29.00ab	29.70a
Fruit width (mm)	21.00a	20.67a	21.33a	21.67a	21.00a	20.67a	20.33a	20.67a
Fruit volume (cm^3)	6.33a	7.50a	7.83a	8.16a	7.33a	7.50a	7.00a	6.83a
Fruit weight (g)	6.10a	7.56a	7.10a	8.13a	7.98a	6.22a	6.33a	6.30a
Pit weight (g)	0.79a	0.98abc	1.02ab	1.08a	0.96abc	0.87bc	0.86bc	0.84bc

Results are reported as the means for 3 replicates, In each row, means supplemented by different letters differed by Dunkans multiple test at the 1% level

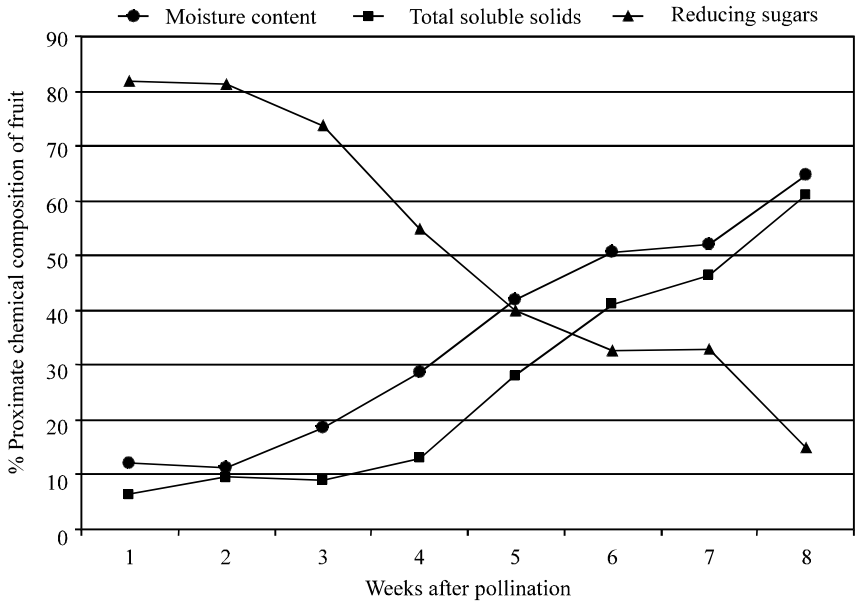

Fig. 1: Composition changes in Shamsaei date during developmental stages

As the dates matured, their weight increased to 8.13 g and then fell to about 6.3 g at the tamr stage. However, according to maturation levels, date fruits vary in color, size and weight. Ashour Ahmed [1] reported physico-chemical properties of 24 date varieties from 3 regions in Lybia and found that the greatest differences in size are between varieties but, within a given variety, the longer dimensions and heavier weights are for the dates at the khalal stage. El-Mardi [9] also observed significant differences in the physical and chemical characteristics of dates during certain stages and reported that an increase in yield associated with reduction in size of fruit and certain chemical constituents and vice versa.

Moisture content: The chemical properties of date are considered important in grading, preservation, storage and processing of dates. The high moisture content will facilitate spoilage of dates and low moisture content will lead to dry dates not acceptable to consumers. Shamsaei dates had a moisture content of 81.33-81.77% at the kimri stage. As the dates matured, the moisture content fell to 54.83% at the khalal stage, but at the rutab stage (20 weeks after pollination) had decreased to 33%. The least amount of moisture was observed at the tamr stage which was about 15% (Fig. 1). However, a decrease in moisture content during ripening observed in our experiments resembles to those obtained by Ahmed *et al.* [12] and Al-Hooti *et al.* [8]. Barreveld [4] reported that moisture content in date fruits at different stages of development is about 50-60% for sweet khalal, about 35-40% for rutab, around 24% for entering the zone of self preservation. Shamsaei dates will mature into tamr on the palm which the fruits at this stage are non perishable and can be stored for a long time. It is due to low moisture content of Shamsaei dates at this stage which prevents growing of yeasts and molds.

Table 2: Averages of pH, acidity and tannin content of Shamsaei date fruits during maturation

	Weeks after pollination							
Property	10 Kimri	12 Kimri	14 Kimri (Turning to yellow)	16 Khalal	18 Khalal (Turning to brown)	20 Rutab	22 Rutab-tamr	24 Tamr
pH	6. 34c	5.64d	6.41c	6.47c	7.45a	7.23ab	6. 96b	7. 01b
Percent acidity (as malic acid)	0.48bc	0.49bc	0.40c	0.43c	0. 39c	0. 6ab	0. 53abc	0. 68a
Total tannin content (%)	1.7a	0.85b	0.66c	0.45d	0.46d	0. 37e	0. 27f	0. 24f

Results are reported as the means for 3 replicates, In each row, means supplemented by different letters differed by Dunkans multiple test at the 1% level

Total soluble solids and reducing sugar content: As fruits matured from kimri to tamr, their chemical composition changed considerably. Figure 1 shows that moisture content decreased progressively from kimri to tamr, but total soluble solids and reducing sugars increased. Total Soluble Solids (TSS) was about 51% at the rutab stage and then increased to around 65% at the tamr stage (22-24 weeks after pollination). It is important to note that the ratio of moisture content is related to sugar content, since dates with low moisture content will contain high sugar and vice versa [1]. Reducing sugars increased slowly during 14 weeks after pollination and there was a rapid increase in them at the khalal stage (Fig. 1). The content of reducing sugars was about 61% at the harvesting time. Mikki [13] reported that Saudi date varieties contain about 70% reducing sugars with an almost equal quantity of glucose and fructose. Ahmed [12] also showed that levels of glucose and fructose increased rapidly through the developmental stages. Similar results have also reported by Al-Hooti *et al.* [8] and Barreveld [4]. However, the decline in moisture content and the increase in sugar contents renders Shamsaei date extremely resistant to fungal spoilage after harvest.

Tannin content: The dates had an initial tannin content of 1.7% at the kimri stage and were significantly astringent (Table 2). As the dates matured, the tannin content decreased to about 0.46% at the khalal stage and reached to 0.24% at the mature tamr stage. Since astringency is attributed to the presence of tannins, it decreases as maturity progresses. Sawaya [3, 14] reported that as dates matured, the tannin content fell. These results are similar to those found by Al-Hooti *et al.* [8] and Barreveld [4]. Myhara *et al.* [2] showed that the green dates were significantly more astringent than those observed at all other stages. In general, the tannins present in green dates are primarily phenolic acids. As the fruits mature, phenolic acids decrease in concentration, while condensed tannins increase in concentration.

pH and percent acidity: The data in Table 2 shows that the dates had the lowest pH 5.6 at the late kimri stage. pH increased through the maturation stages and reached to a maximum of 7.45 at the end of khalal stage. Then it fell to about 7 at the final stage of maturation (tamr). Percent acidity was about 0.49% for the green dates and reached to 0.39% at the beginning of rutab stage. However, acid content tends to go down during maturation but in warm condition and high humidity during maturity and also harvesting time, acidity may increase. Barreveld [4] stated that there was a definite correlation between increasing commercial quality and increasing pH for Deglet Noor date.

CONCLUSIONS

Shamsaei dates at various levels of maturity were examined for physical and chemical characteristics. It was found that physico-chemical properties of Shamsaei date fruits changed during maturation. The dates had the longer dimensions and heavier weights at the khalal stage. The least amount of sugar and the highest moisture content were observed at the kimri stage of maturity. However, our observations have shown that moisture content decreases but total soluble solids and reducing sugars increase during maturation. The green dates had the highest tannin content and were more astringent than dates at all other stages. pH tends to increase during maturation. Owing to moisture loss, tamr dates contain a higher concentration of sugars than dates at the rutab stage of maturity and are therefore sweeter. Shamsaei dates are harvested at the tamr stage, when the fruits have about 65% sugar content.

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