Impact of drying methods on physicochemical and sensory properties of apricot pestil

Senem Suna, Canan Ece Tamer*, Bige İncedayı, Gülşah Özcan Sinir & Ömer Utku Çopur

Department of Food Engineering, Faculty of Agriculture, Uludag University, 16059 Gorukle, Bursa, Turkey
E-mail: etamer@uludag.edu.tr

Received 28.06.13, revised 19.08.13

Fruit leathers, or traditionally named as pestil are intermediate moisture pectic gels, eaten as snack, manufactured by dehydration of fruit pulp into leathery sheets. The aim of the study was to evaluate physicochemical and sensory properties of apricot pestil dried with different methods. One group was sun dried, other group was dried in vacuum oven at 55°C and the last one was dried in microwave oven (90 W). Analysis of moisture, water soluble dry matter, pH, titratable acidity, total and reducing sugar, hydroxymethylfurfural, total phenolic compounds, antioxidant activity, minerals (K, Ca, Mg, Zn), color ($L^*$, $a^*$, $b^*$) and sensory analysis were carried out. The moisture contents of apricot pestil samples were between 13.12±1.35 - 14.39±0.41 gm/100 gm. The HMF content of samples was affected by drying method. The HMF contents of microwave oven dried, vacuum oven dried and sundried pestil samples were 13.62±0.78, 19.39±0.26 and 45.64±1.29 mg/kg, respectively. Total phenolic compounds in samples were determined as between 110.03±0.72 - 121.24±6.19 mg GAE/100 gm. Retention of antioxidant activity of the sundried, microwave oven dried and vacuum oven dried samples was 59.80%, 39.23% and 19.15%, respectively. The mineral contents of pestil samples were higher because of increasing dry matter content. When comparing drying times, the shortest was observed in microwave oven drying followed by sun drying and vacuum oven drying. Drying methods considerably influenced the color changes of pestil samples. Chromatic parameters $a^*$, $b^*$, $\Delta E_{ab}^*$ and $C_{ab}^*$ were found higher in microwave oven dried samples. Sensory evaluation analysis showed that all of the samples were acceptable by the panelists. The results of the analysis were important for selecting the quality criterion and for characterizing of this traditional product.

Keywords: Apricot pestil, Antioxidant activity, Total phenolics, Microwave oven drying, Sundrying

IPC Int. Cl.: A61K 36/00, C09K 15/00, G01N, F26B, A23B 7/00, A23N 12/00

Dried fruits and vegetables have been regarded as alternative fat free snacks and received more attention from the food industry during the past decade. Fruit leathers are dehydrated fruit based products that are eaten as candy or snacks, and presented as flexible stripes or sheets. The origin of fruit leathers may go back to the Persian Empire. They are known as Pestil in Turkey and Fruit leather in the United States. They receive this name because of the final product aspect (it is shiny and has the texture of leather). The drying of fruit to prepare leathers offers a convenient method of marketing fruits that are abundant for fresh fruit market. Due to their attractive appearance, and because they do not normally require cold storage to avoid microbial growth, fruit leathers constitute a practical way to increase fruit solids consumption, especially for children and young people.

Pestil is one of the most important traditional foods produced and consumed in different regions of Turkey. There are grape pestil, apricot pestil, plum pestil and mulberry pestil, among others. Fruit combinations make a variety of flavors possible. However, acceptable leathers cannot be prepared from juicy fruits until suitable additives such as maltodextrin, pectin, soluble starch, carboxy methyl cellulose, etc. are added. The processing steps of pestil depend on the fruit used and, for apricots, consist of sorting, washing, pitting, pre-heating, pressing, starch addition, evaporation, spreading, drying, cutting and packaging. Moisture is removed from a large flat-tray of wet puree until the desired cohesive ‘leathery’ composition is obtained. When dried, the product is pulled from the surface, rolled and consumed as snack. Control of the drying temperature is very important, as very high values often cause surface hardening, hindering the outflow of water. Besides, controlling the fruit puree load is
also important, as if the puree layer is excessively thin, the resulting product may be brittle and difficult to remove from the surface. In contrast, a too thick puree layer results in a very low drying rate. Drying of fruit leather is a process which involves simultaneous heat and mass transfer. Various methods of drying and drying conditions affecting quality of fruit leathers have been previously studied. Sun drying allows the production of a pestil with a live color and translucent appearance. However, the drying time is long and dependent on weather conditions, while the product is exposed to environmental contamination. Microwave oven drying usually takes a shorter time to dry pestil samples compared with other methods of drying. Hot air drying is a conventional drying method, which decreases drying time. However, conventional drying with high air temperature and long drying time may cause serious damage to quality attributes of the product such as flavor, color, nutrients, and reduction in bulk density and rehydration capacity of the dried product. For this reason, different dehydration processing schemes have been proposed for the production of fruit leathers including single type dehydration or combined methods of drying.

Natural fruit pulp based fruit leathers are nutritious and organoleptically acceptable since substantial quantities of dietary fiber, minerals and vitamins are the constituents of final product. Pestil is pleasant to chew and quite tasty. As, it is low in moisture, stored for a long term period and economical to ship when comparing with fresh fruit. Pestil production is used to increase shelf life and protect nutrients for longer periods especially during winter. Pestil is a good source of carbohydrate, energy, minerals such as, Fe, F, Ca, K and vitamins especially thiamine and vitamin B6. Also mentioned that apricot pestil is rich in potassium, calcium, sodium and zinc. According to the results of their research, apricot pestil (100 gm) would be sufficient to provide approximately 70% of the potassium, 20% of the sodium and 30% of the iron needed for the Recommended Daily Allowance (RDA).

It is worth to note that fruit leathers, which is a value added product, have a steady and growing market and are well established products, particularly in the American market. It is becoming a popular alternative to fresh fruits and the demand for fruit leather is increasing constantly in the international market. Fruit leather is easy to eat, convenient to pack, and makes an ideal snack almost anywhere. In United States, dehydrated fruit leathers have been utilized, by astronauts during space explorations, by explorers, hikers, backpackers and others who must carry their food supplies along with them. Undoubtedly, fruit leathers have a steady and growing market that exists in United States and Canada. Confectionary like sweets and candies made from a high amount of sugar, has very little nutritional value and could cause tooth decay among children. Fruit leathers could be an alternative confectionary not only to children but to adults as well.

The apricot (Prunus armeniaca L.) fruit is considered as one of the most delicious temperate fruits and consumed because of its delicate flavor and high nutritional quality. The greatest percentage of the world’s apricot production comes from the countries around the Mediterranean Sea, that is Turkey, Spain, Italy, France and Greece. Apricots could be consumed as whole fresh fruits, fruit juice, dried fruits, fruit puree, jam, marmalade, pestil or as vinegar. It is a rich source of carbohydrates and minerals besides having attractive color and typical flavor. Sugars like glucose, fructose, sucrose, sorbitol, and malic and citric acid are the principal constituents. Apricot is also a good source of minerals such as potassium and iron. The apricot fruit is an important source of provitamin A carotenoids since 250 gm of fresh or 30 gm of dried fruit provides 100% of the RDA of carotenoids. The major carotenoid compound found in apricots is β-carotene, constituting 60-70% of the total carotenoid level. The major phenolic compounds in apricot are chlorogenic and neo-chlorogenic acids, (+)-catechin, (-)-epicatechin and rutin (or quercetin-3-rutinoside).

The aim of this work was to describe the effect of drying methods such as sundrying, vacuum oven drying and microwave oven drying on physiochemical properties and retention of some nutrients, antioxidant capacity and organoleptic quality of apricot leathers. The technical knowledge about drying process is based on many literatures. But the researches about different kinds of pests and drying methods are limited. So, this research is focused on apricot leather production and the effects of different methods on numerous parameters as practically.

Materials and Methods

Materials

Apricots were harvested in an orchard in Malatya province, Turkey, in August 2011 and stored ±4 °C. Prior to pestil preparation, apricots were taken out of
storage and processed. Starch (4%) was used for the aimed viscosity of the mixture and the sensorial improvement of this traditional product. Distilled water was used for all experiments.

Preparation of pestil
Fruits were washed, cut and pitted then processed using a domestic blender (Beko, Turkey), until obtaining a homogenous pulp. Initial total soluble solid (°Brix) of pulp was 20 gm/100 gm. 3/4 part of pulp was boiled in an open kettle for 20 min at constant stirring to obtain paste with 45 °Brix. Then, freshly prepared wheat starch and pulp mixture (starch dissolved in 1/4 part of pulp left) was added to the boiling paste. This was done to prevent formation of lumps and uniformly disperse the starch. It was boiled for 5 min more. Cooked apricot paste–starch mixture (approximately 100 gm) was evenly spread on a 20 cm diameter cloth. The samples were dried from one side (top surface). The drying methods were sun drying under direct sunlight (345 min), vacuum oven (Nüve EV 018, Turkey) drying (55°C, 720 mm Hg, 450 min) and microwave oven (unmodified commercial Bosch Hmt72g420, Germany, 2450 MHz) drying (90 W, 55 min). The weather temperature was around 30-31°C, the percent average relative humidity was 58 and UV intensity was high (7-8 UV index). The drying experiments were conducted in duplicate. The appearance of pestil was yellowish orange with a smooth surface. After drying, pestil samples were pulled from the surface and packaged with low density polyethylene film and stored at room temperature until analyzed.

Physicochemical analysis
Moisture content, water soluble dry matter, pH, titratable acidity, total and reducing sugar, total phenolic compounds, antioxidant activity, content of minerals (K, Ca, Mg, Zn), surface color \((L^*, a^*, b^*)\) and sensory analysis were conducted. Moisture of pestil samples was determined by oven drying method. Water soluble dry matter of apricot pulp was expressed as gm /100 gm by using an Abbe refractometer. Titratable acidity was determined by diluting 5 gm of the pulp with 50 ml of distilled water and titrating to \(pH\) 8.1 with 0.1 N NaOH and expressed as citric acid content. The \(pH\) of apricot pulp was measured by using a Sartorius Basic PB-11 Model Laboratory \(pH\) meter. Total and reducing sugars were determined by the Luff-Schoorl method. Hydroxymethylfurfural (HMF) was identified by measuring the absorbance variation of the samples by barbituric acid and p-toluidine, using a spectrophotometer. The procedure carried out to determine antioxidant activity in apricot and apricot pestils was based on inhibition of the free radical 2,2-diphenyl-1-picrilhydrazil (DPPH) in methanolic extracts of the samples. DPPH radical has an intense violet color but turns colorless as unpaired electrons are sequestered by antioxidants. In this method, extracted samples, which were made to react with the radical solution and rest for 30 min at room temperature, were measured for absorbance at 517 nm, and the inhibition percentage of DPPH free radical was calculated. The extracts for antioxidant activity were tested at concentration of 8 mg/ml on dry basis. Antioxidant activity values were analyzed on dry basis for comparing the raw material and pestil samples with different dry matter contents. The method employed for the total phenolics was based on Folin-Ciocalteau’s phenol reagent, followed by spectrophotometric determinations carried out at 452 nm using a Shimadzu UV 1208 equipment, and the results were calculated as gallic acid equivalents. For determination of color values, Hunter colorimetric system was applied by Miniscan EZ4500L model HunterLab colorimeter. The measurements were displayed in \(L^*\): lightness, \(a^*\): redness, \(b^*\): yellowness. The surface color of pestils was measured on different parts and expressed as the mean of three replicate readings. Total color difference \((\Delta E_{ab}^*)\), chroma \((C_{ab}^*)\) and hue angle \((h^\circ)\) values were calculated from \(L^*, a^*, b^*\) values. For analysis of the mineral content NMKL (2007) method was employed and Agilent 7500 CX (Agilent Technologies, Santa Clara, CA, USA) model ICP-MS was used. According to this method, 0.5 gm homogenized sample, 4 mL HNO\(_3\) (65%) and 1 ml H\(_2\)O\(_2\) (35%) were incinerated in microwave digestion system (Berghof mws3). The digested sample was transferred to a 50 mL volumetric flask and diluted with distilled water. Triplicate measurements were performed for all physicochemical properties in each batch of apricot pestil samples.

Sensory analysis
Sensory attributes of products as color, appearance, taste and chewiness were evaluated by five trained panelists selected among staff and graduate students of the Food Engineering Department (Uludag University). A 9-point structured hedonic scale was used to evaluate the samples. The results were rated
on points as 9: like extremely, 8: like very much, 7: like moderately, 6: like slightly, 5: neither like nor dislike, 4: dislike slightly, 3: dislike moderately, 2: dislike very much, 1: dislike extremely (Fig. 1).

The samples were coded with three digits random numbers, not more than three samples were served in a randomized order. Prior to the test, panelists were briefed about the questionnaire and instructed to visually evaluate product acceptability for color and appearance. Afterwards, they were instructed to masticate a piece of the test sample and before providing acceptability ratings for chewiness and taste. Unsalted crackers and water were provided in between samples.

**Statistical analysis**

The experiment was conducted in a completely randomized design with two replications. The results were statistically evaluated by one-way analysis of variance (ANOVA) using the JMP software package version 5.0 (SAS Institute Inc. NC, 27513). The significance of the treatments was determined at the 0.05 probability level by using LSD test.

**Results and discussion**

Three different drying methods were compared by plotting percentage of remaining weight vs. drying time (Fig. 2). The time of drying in manufacturing of fruit leathers vary, depending on the type of fruit and the dryer used. The high temperature of the drying process is an important cause for loss of quality. For this reason, lowering the process temperature has great potential for improving the quality of dried products. Vacuum drying is an important process for heat sensitive materials.

Percentage of remaining weight was found as 51.5, 53.3, 52.2 for sun dried, vacuum oven dried and microwave oven dried samples respectively at the end of their drying period. According to these data, microwave oven drying (55 min) was the fastest method followed by sun drying (345 min) and vacuum oven drying (450 min). Use of microwave energy in drying offers reduced drying times and complements conventional drying in later stages by specifically targeting the internal residual moisture.

Maskan et al. mentioned that depending on sample thickness and air temperature, the drying time ranged between 50–140 min to achieve the commercial moisture content of grape pestil (0.12 kg H₂O/kg dry solids) in air drying. Whereas, sun drying took 180–1500 min in this study. Analytical results pertaining to proximate composition of the apricot fruit used for pestil production are presented in Table 1. Mean values of total dry matter, pH and acidity were similar to those reported by Haciseferoğlu et al. who determined postharvest chemical and physical–mechanical properties of some apricot varieties cultivated in Turkey. They determined dry matter as between 16.73–22.63%, pH as 4.16-5.23 and acidity (malic acid) as 0.17–0.79%. Drogoudi et al. evaluated physical and chemical properties of apricot cultivars of Greek and American origin and their hybrids. They determined total sugars as between 43.1 - 62.2 % (dry weight), total phenol content between 0.303 and 7.422 mg gallic acid equivalent gm⁻¹ fresh weight. The amount of total phenolics in fresh apricot sample was comparable with results reported by Ruiz et al. (0.202-1.202 mg gm⁻¹ fresh weight). K, Ca, and Mg are considered as major minerals of the apricot fruit.
Haciseferoğulları et al.\textsuperscript{40} measured higher amounts of K (20791-33364 ppm), Ca (843.28-1896.53 ppm) and Mg (402.82-765.62 ppm) in apricot samples. According to many studies, composition of the fruits was affected by climate, variety, geographical origin, harvest year and the methods of cultivation\textsuperscript{42}. Color values coincided with results reported by Ihns et al.\textsuperscript{43} They determined the average $L^*$, $a^*$ and $b^*$ color values of two different apricot varieties as between 52.1 - 56.9, 24.3 - 26.7 and 44.5 - 50.1, respectively. Discrepancies between data in the present study and the other researches could be the result of a wide variety of factors such as cultivar, environmental and storage conditions of the apricot.

The results of the physicochemical analysis of the apricot pestil dried with different methods were given in Table 2. The moisture contents of the apricot pestil samples were between 13.12±1.35 - 14.39±0.41 gm/100 gm. The final moisture contents of apricot pestils were designated according to literature data, pre-treatments and organoleptic properties. It has also been speculated that moisture contents at or below 15\% (wet basis) for most fruits is a rather safe indication that there is no microbial or mould growth and the reaction rate of a number of other deteriorative reactions (sugar crystallisation, non-enzymatic browning, flavour deterioration, lipid oxidation, etc.) is significantly reduced\textsuperscript{13}. It was determined in pre-treatments that less moisture contents caused caramelisation reactions. Ekşi & Artık\textsuperscript{7} reported the moisture content of apricot pestil as 17.3\%. While the moisture content of grape pestil was reported as 11.2±0.1 gm/100 gm,\textsuperscript{8} it was determined as 17.2\% in mango leather\textsuperscript{16}. Çağındı and Ötleş\textsuperscript{8} determined the moisture content as between 13.0 ± 0.25 - 18.3 ± 0.10 (\%) in apricot pestil samples. Torley et al.\textsuperscript{24} examined six fruit leathers commercially manufactured in Australia. Substantial variation in moisture (7.4 - 18.1\%) and sugar content (31.9 - 62.0 \%) of the samples determined.

Ekşi & Artık\textsuperscript{7} reported higher total sugar content of apricot pestil as 80.1\%. Reducing and total sugar contents of the samples were between 24.00±0.44 - 27.35±0.00 and 51.32±1.11 - 61.40±0.52 g/100 gm, respectively. Şengil et al.\textsuperscript{17} determined total and reducing sugars between 30.91 - 54.60\% and 21.38 - 41.05\%, respectively. Similarly, it varied from 20.9 to 26.3\% in pineapple leathers\textsuperscript{15}.

The differences between the titratable acidity of the samples were not significant. Titratable acidity (as malic acid) of the pestil samples produced from different fruits was changed between 0.06 - 6.25\%\textsuperscript{17}.

The effect of processing conditions on HMF content of the apricot pestil was firstly determined in this research. While the lowest HMF content (13.62±0.78 mg/kg) was determined in microwave oven dried pestil, the highest HMF content (45.64±1.29 mg/kg) determined in sun dried pestil. HMF content of vacuum oven dried pestil sample (19.39±0.26 mg/kg) was also lower than sun dried one, significantly. When comparing drying times, the shortest value was observed in microwave oven drying and it was followed by sun drying and vacuum oven drying. Heat treatment applied for fruit leather production often reduces the number of original volatile flavour compounds of fruits, while introducing additional volatile flavor compounds through the auto-oxidation of unsaturated fatty acids and thermal decomposition, and initiation of Maillard reactions. The products of these reactions (mainly hydroxymethylfurfural-HMF) are characterized by raised antioxidant potential. The newly formed Maillard products, besides increasing the antioxidant capacity, can reduce polyphenol oxidation by inhibition of polyphenol oxidase. However, the reported effects of Maillard products on human health are quite contradictory. They have been found to have mutagenic or antimutagenic activity\textsuperscript{22}. The destruction of pigment components and occurrence of Maillard reactions may occur due to cooking and drying of pestil at high temperature\textsuperscript{17}. The difference between total phenolic matter content of the pestil samples was statistically significant. The phenolic compound concentrations of the dried pestil samples were higher than the concentration of fresh apricot due to the moisture loss. The increase in total phenolics is possibly due to the liberation of phenolic compounds from the matrix during the drying process. Drying
Antioxidant activity were tested at concentration of 8 mg/ml on content of vacuum oven dried apricot pestil. Vacuum drying might have decreased the phenolic constituents and decreased for increasing air temperatures even when the resulting drying times were shorter. Although Orrego et al.21 reported that the vacuum dehydration methods lead to higher retention of antioxidants better color, texture and higher rehydration capacity, sun dried pestil had the highest antioxidant activity and was preferred for sensory attributes such as color, appearance and chewiness in this research (Fig. 1). This result might be originated from necessity of longer drying period for vacuum oven drying. Quintero Ruiz et al.45 emphasised that if considered a functional food, fruit leathers should be stored under refrigeration so as to minimize antioxidant activity losses.

Pestil is important sources of minerals. The amount of minerals of pestil samples was higher because of increasing dry matter content. The differences between K and Mg contents of pestil samples were not statistically significant. Except from Mg and Zn, the highest mineral values were determined in microwave oven dried samples.

The color of apricot pestil can be described as yellowish orange and is a very important parameter in determining consumer preference. Values of $L^*$, $a^*$, and $b^*$ after three drying methods applied were changed between 44.37±0.85-49.06±0.38, 16.22±0.52 -20.81±1.07 and 33.81±1.64-41.76±1.22, respectively (Table 2). Compared with raw apricot pulp, apricot leathers were darker (lower $L^*$ values). Drying methods exerted a significant effect on the color changes of pestil samples. $L^*$ (lightness) value of samples decreased by after all drying methods. $a^*$ and $b^*$ values describes redness and yellowness of samples. Redness and yellowness were significantly higher in microwave oven dried sample. While the differences between $a^*$ values of the pestil samples were not significant in sun dried and vacuum oven dried samples, the differences between the values of $b^*$ were not significant in sun dried and microwave oven dried samples. Çağında and Öteş8 reported that $L^*$, $a^*$ and $b^*$ values varied from 88.04 to 100.85, 10.26 to 12.85 and -6.33 to 13.27 in apricot pestil samples. Şengül et al.47 also measured these color values as 27.35-41.35, 1.25-11.50 and 0.99-18.22, respectively. Total color difference ($\Delta E_{ab}^{*}$) values of pestil samples also were changed between 16.22±0.52 -20.81±1.07 and 33.81±1.64-41.76±1.22, respectively. Total color difference ($\Delta E_{ab}^{*}$) and chroma ($C^*_{ab}$) values of pestil samples also were changed between 64.32±0.89 – 58.38±1.79 and 46.67±0.61–37.94 ± 1.76, respectively. $\Delta E_{ab}^{*}$ and $C^*_{ab}$ values were found significantly higher in microwave oven dried pestil sample.

The hue angle ($h^o$) ranges from 0° to 360°, where 0° is purplish-red and 90° is yellow48. $h^o$ value of all samples ranged from 63.01±0.24 to 67.06±0.23 (Table 2 ) indicating somewhat yellowish color. The highest $h^o$ value was determined in sun dried samples.

### Table 1—Results of the physicochemical analysis of the apricot fruit

<table>
<thead>
<tr>
<th>Analysis</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total dry matter (gm/100 gm)</td>
<td>21.39±0.1</td>
</tr>
<tr>
<td>Water soluble dry matter (gm/100 gm)</td>
<td>20.75±0.1</td>
</tr>
<tr>
<td>Total sugar (gm/100 gm)</td>
<td>14.62±0.63</td>
</tr>
<tr>
<td>Reducing sugar (gm/100 gm)</td>
<td>6.56±0.13</td>
</tr>
<tr>
<td>Titratable acidity (gm/100 gm)</td>
<td>0.33±0.00</td>
</tr>
<tr>
<td>pH</td>
<td>4.71±0.00</td>
</tr>
<tr>
<td>Total phenolic matter (mg GAE/100 gm)</td>
<td>60.34±0.30</td>
</tr>
<tr>
<td>Minerals (mg/kg)</td>
<td></td>
</tr>
<tr>
<td>K</td>
<td>3849±114.55</td>
</tr>
<tr>
<td>Ca</td>
<td>245±12.73</td>
</tr>
<tr>
<td>Mg</td>
<td>101±3.53</td>
</tr>
<tr>
<td>Zn</td>
<td>0.27±0.00</td>
</tr>
<tr>
<td>Antioxidant activity (%)</td>
<td>46.52±0.10</td>
</tr>
<tr>
<td>Color</td>
<td></td>
</tr>
<tr>
<td>$L^*$</td>
<td>65.77±0.18</td>
</tr>
<tr>
<td>$a^*$</td>
<td>21.97±0.34</td>
</tr>
<tr>
<td>$b^*$</td>
<td>49.90±1.74</td>
</tr>
<tr>
<td>$\Delta E_{ab}^{*}$</td>
<td>85.14±0.95</td>
</tr>
<tr>
<td>$h^o$</td>
<td>66.14±0.36</td>
</tr>
<tr>
<td>$C^*_{ab}$</td>
<td>54.15±1.46</td>
</tr>
</tbody>
</table>

**Note:**
- citric acid †† GAE: gallic acid equivalent †††
The extracts for antioxidant activity were tested at concentration of 8 mg/ml on dry basis.

**Minerals (mg/kg):**

- K 3849±114.55
- Ca 245±12.73
- Mg 101±3.53
- Zn 0.27±0.00
- Antioxidant activity (%)††† 46.52±0.10

**Color:**

- $L^*$ 65.77±0.18
- $a^*$ 21.97±0.34
- $b^*$ 49.90±1.74
- $\Delta E_{ab}^{*}$ 85.14±0.95
- $h^o$ 66.14±0.36
- $C^*_{ab}$ 54.15±1.46
For sensorial test, panelists were briefed about the properties of apricot pestil. The product should have bright yellow color related with color of apricots, should not be burned or browned, while the typical apricot taste and aroma should be appreciated. Pestil should not be stick on teeth and be easily chewable. Sun dried pestil sample was preferred for color, appearance and chewiness. However vacuum dried pestil was selected for taste. All of the apricot pestil samples were generally acceptable by the sensory panelists.

**Conclusion**

Consumption of fruits as a significant portion of daily diets has been associated with a lower risk of coronary heart disease and cancer. Given the wide range of bioactive factors in fresh fruits preserved in pestil, it is possible that their uptake have a positive effect in reducing the risk of many diseases. The consumer trend nowadays is towards more natural snack foods. For this reason, the preparation method of this traditional product should be defined, or standardized to inform consumers and to favor trade at national and international level. Pestil production is an alternative to increase the commercial value of the fruit, particularly when there is an over production of the fruit during a season. It has long shelf life and can be stored without deterioration. For the diabetic people, pestil made without sugar could be a healthy preference as a snack and it has the potential to increase fruit solids especially in the young. Economically feasible alternative processing technologies, drying conditions and additives should be tested, in order to determine a suitable procedure for developing pestil while preserving their nutritional value. Apricot pestil is a good source of energy and minerals. It can be an alternative confectionary not only for children but for adults as well. It is important to increase consumption of this nutritional and beneficial product as an alternative appetizer.

For sensorial test, panelists were briefed about the properties of apricot pestil. The product should have bright yellow color related with color of apricots, should not be burned or browned, while the typical apricot taste and aroma should be appreciated. Pestil should not be stick on teeth and be easily chewable. Sun dried pestil sample was preferred for color, appearance and chewiness. However vacuum dried pestil was selected for taste. All of the apricot pestil samples were generally acceptable by the sensory panelists.

**Conclusion**

Consumption of fruits as a significant portion of daily diets has been associated with a lower risk of coronary heart disease and cancer. Given the wide range of bioactive factors in fresh fruits preserved in pestil, it is possible that their uptake have a positive effect in reducing the risk of many diseases. The consumer trend nowadays is towards more natural snack foods. For this reason, the preparation method of this traditional product should be defined, or standardized to inform consumers and to favor trade at national and international level. Pestil production is an alternative to increase the commercial value of the fruit, particularly when there is an over production of the fruit during a season. It has long shelf life and can be stored without deterioration. For the diabetic people, pestil made without sugar could be a healthy preference as a snack and it has the potential to increase fruit solids especially in the young. Economically feasible alternative processing technologies, drying conditions and additives should be tested, in order to determine a suitable procedure for developing pestil while preserving their nutritional value. Apricot pestil is a good source of energy and minerals. It can be an alternative confectionary not only for children but for adults as well. It is important to increase consumption of this nutritional and beneficial product as an alternative appetizer.

It was determined that traditional sun dried apricot pestil has a good nutritional quality and organoleptic characteristic compared to other samples produced by microwave and vacuum oven drying. However, the improvement and standardization of this method in terms of hygiene, drying period and environmental conditions of product should be proposed.

**Table 2—Results of the physicochemical analysis of the apricot pestil samples**

<table>
<thead>
<tr>
<th>Analysis</th>
<th>Sun dried Pestil</th>
<th>Microwave oven dried pestil</th>
<th>Vacuum oven dried pestil</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture (gm/100 gm)</td>
<td>14.39±0.41</td>
<td>13.25±0.28</td>
<td>13.12±1.35</td>
</tr>
<tr>
<td>Total sugar (gm/100 gm)</td>
<td>58.83±0.71a</td>
<td>51.32±1.11b</td>
<td>61.40±0.52a</td>
</tr>
<tr>
<td>Reducing sugar (gm/100 gm)</td>
<td>26.14±0.35b</td>
<td>24.00±0.44c</td>
<td>27.35±0.00a</td>
</tr>
<tr>
<td>Titratable acidity † (gm/100 gm)</td>
<td>0.69±0.00</td>
<td>0.81±0.00</td>
<td>0.75±0.00</td>
</tr>
<tr>
<td>Hydroxymethylfurfural (mg/kg)</td>
<td>45.64±1.29a</td>
<td>13.62±0.78c</td>
<td>19.39±0.26b</td>
</tr>
<tr>
<td>Total phenolic matter (mg GAE/kg)</td>
<td>121.24±6.19a</td>
<td>120.06±1.16b</td>
<td>110.03±0.72c</td>
</tr>
<tr>
<td>Antioxidant activity (%)</td>
<td>27.82±0.10a</td>
<td>18.25±0.32b</td>
<td>8.91±0.10c</td>
</tr>
<tr>
<td>Minerals (mg/kg)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>K</td>
<td>1457.98±250.94</td>
<td>14981.34±30.36</td>
<td>14770.06±117.63</td>
</tr>
<tr>
<td>Ca</td>
<td>843.13±27.37c</td>
<td>1063.44±9.56a</td>
<td>950.68±12.51b</td>
</tr>
<tr>
<td>Mg</td>
<td>439.06±1.99</td>
<td>419.26±13.60</td>
<td>414.48±1.69</td>
</tr>
<tr>
<td>Zn</td>
<td>6.89±0.91b</td>
<td>10.17±0.71a</td>
<td>12.00±0.67a</td>
</tr>
<tr>
<td>Color</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L*</td>
<td>49.06±0.38a</td>
<td>47.47±0.08a</td>
<td>44.37±0.85b</td>
</tr>
<tr>
<td>a*</td>
<td>16.22±0.52b</td>
<td>20.81±1.07a</td>
<td>17.22±0.66b</td>
</tr>
<tr>
<td>b*</td>
<td>8.31±0.79a</td>
<td>1.76±1.22a</td>
<td>33.81±1.64b</td>
</tr>
<tr>
<td>ΔE_ab*</td>
<td>4.32±0.89b</td>
<td>6.57±0.36a</td>
<td>58.38±1.79c</td>
</tr>
<tr>
<td>h°</td>
<td>7.06±0.23a</td>
<td>3.50±1.85b</td>
<td>63.01±0.24c</td>
</tr>
<tr>
<td>C_ab†</td>
<td>1.60±0.93b</td>
<td>6.67±0.61a</td>
<td>37.94±1.76c</td>
</tr>
</tbody>
</table>

†: citric acid †† GAE: gallic acid equivalent †††: The extracts for antioxidant activity were tested at concentration of 8 mg/ml on dry basis.
References


