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# Comparison of the new method in purification and decolorization of date juice with the commercial technique

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**Abstract**

Research seems to be essential about lateral products of dates including date juice, due to its high rate of loss and inattention to the lateral products and relevant processes in the country. This study was done in order to achieve the best purification and decolorization conditions of date juice. After processing with saturated lime in the new method of purification and decolorization, the extracted date concentrate got the appropriate pH for colloids and then it obtained the optimum pH for formation of calcium phosphate by phosphoric acid. Also, Purosorb PAD 900 absorbing resin (made in England) was used for decolorization. Bentonite and gelatin were used for purification, and decolorization was done by active carbon in the commercial technique. Statistical analysis was done by SPSS 19 software. The results showed turbidity had reduced in liming-phosphatation and gelatin-bentonite for purification to 98% and 40%, respectively. Moreover, decolorization with absorbing resin caused decolorization of the colors with the wavelengths of 420 and 560 nanometers by 89% and 80%, respectively, while active carbon provided 30% and 78% of decolorization for the above wavelengths.

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**Introduction**

The history of human beings using the product of palm trees as a valuable nutrition goes back to about 6 thousand years B.C. As for creating a food security, occupation and getting income, preserving the environment and sustainable agricultural development, it is considered as a strategic product that is regarded as the crisis fruit, since in unforeseen events, it is among the first products sent to damaged areas (Gohariardebili *et al*., 1384).

Due to producing 2830kcal and having vast amounts of vitamins $B_1$, $B_2$ and C and various minerals such as sodium, potassium, phosphorous and iron, it is considered as quite a valuable product for nutritional purposes (Ahmad- nia *et al*., 1387).

Date has 2-6% of colloid pectin with negative load, formed from galacturonic acid molecules linked with alpha links (1→4), and compositions including araban, xylan, galactan and rhamnose are linked with its galacturonic 2 & 3 chemical structure links (Fatemi, 1387).

Pectin together with other compounds such as cellulose, phenol substances, protein and araban exist in the cellular walls of the dates, being considered as an important element for turbidity in the extracted date juice (Sharifan *et al*., 1384).

Some compositions like pectin, protein, resins and other colloid substances could pass from the filtrations after extracting sugared juices, causing turbidity. Hence, processes such as removal of turbidity and purification of extracts seems to be essential. Purification of raw cane juice by phosphoric acid and line was prevailed in 1880s, although the produced calcium phosphate for purification was separated by cotton and canvas filters with difficulty. George Williamson proposed a continuous system in 1918 to purify sugarcane juice, based on using lime and phosphates. He found that air bubbles were trapped inside the juice by rotating and moving the sugared juice mixture, causing ascending of impurities to the upper part of the juice vessel (Poel *et al*., 1998; Saravacos *et al*., 2010). One of the most common ways of purifying sugared juices today is using lime and phosphoric acid (Poel *et al*., 1998).

As a whole, purification methods of juices by liming is based on two principles:

1. Flocculation of colloid compositions and sedimentation of non-sugared (sugar free) substances in alkaline environment.

2. Absorbing the formed crystals from lime reactions with carbon dioxide or phosphoric acid (Poel *et al*., 1998).

The formulas for phosphoric acid and lime reactions are as follows:

$$_8Ca(OH)_2 + _6H_3PO_4 \quad Ca_8H_2(PO_4)_6 + _{16}H_2O$$

In the liming stage of alkaline purification, the juice purification is done via colloid flocculation and their sedimentation and also absorbing some anions such as phosphoric acid and other acids anions to their insoluble calcium minerals.

In the next stage, the purification is completed by adding definite amount of phosphoric acid or carbon dioxide, and the coagulated materials in the liming stage as well as the soluble non-sugared substances, especially the colored compounds are absorbed by very small particles of calcium phosphate or calcium carbonate, according to the adsorption phenomenon, and then they are separated from the juice, by special filters (Eski, 2000).

Another way to purify carbohydrate extracts, especially raw sugarcane juices, is using gelatin and bentonite; this type of purification is considered to be among chemical methods (Asadi, 2006). Bentonite is aluminum silicate clay produced by volcanic ash and used for reducing the amount of protein in raw juice with its ion exchange potentials (Eski, 2000). Gelatin is the derived protein from collagen, produced from animals' bones, skins and cartilages, and it is used as

a processing aid, purifying, thickening and tissue aid material (Fatemi, 1387). Gelatin and bentonite are used for eliminating tannins, pigments and other impurities (Eski, 2000). Gokmen *et al.* (2002) stated that by increasing temperature, the efficiency of adsorption of the compositions for turbidity and color elements in apple juice increases by the absorbing resins and bentonite (Shahdadi *et al.*, 1390). Farmani *et al.* (2006) reported that by increasing the temperature, elimination of the compositions causing turbidity and color from raw sugarcane juice increases by bentonite and using excessive gelatin and bentonite from the date juice increases turbidity of raw sugarcane juice (Shahdadi *et al.*, 1390). Erdogan *et al.* (1996) examined the effects of 5 types of bentonite, one type of sepiolite, and a type of diatomite in separating turbidity and color pigments in sugar beet extract by the presence of 4+ ammonium (600ppm). The results of the research showed that the rates of changing turbidity and color will reach 33% by bentonite, 44% by sepiolite, and 31.5% by diatomite (Eski, 2000).

This study was done with the aim of introducing the new method of liming-phosphatation in purifying, and using absorbing resins in decolorization of date juice instead of active carbon, and comparing the processed extract using this method with the ordinary industrial methods.

**Materials and methods**

*Purification and Decolorization of Daye Juice by New Method*

10kg of date (of Shahani variety) was made into pulp form by a home mincer (Matsushita electric, Osaka, Japan and extracting date juice was done by the mutual method and using the extracting enzyme of Rapidase Smart and the clearing enzyme "Rapidase Max C-80" (DSM Co. Netherlands) (Loghmani *et al.*, 1391). Then, saturated lime (with 20 Baume scale) was prepared and the pH rate of the extracted date juice that was 4.5 increased to 9.5. Liming was done in cold condition, since this method is suitable for the extracts with high rate of invert sugar (Poel *et al.*, 1998). The saturated lime was added to the date juice in the ambient temperature, in this method and its rate was estimated about 3% up to reaching pH=9.5. The mixture of lime and the extract was blended for 15min. by Hotplate Magnetic, and the temperature of the mixture was set to 60˚C, to reduce the juice viscosity. After 15min. that coagulation of colloid compositions and transformation of weak organic acids to calcium minerals were done, the mixture pH was gradually reduced to "5", by orthophosphoric acid 85% (Fluca, Germany), and filtration was done by a cotton fabric filter.

A scaled cylinder with the height of 50cm and approx. volume of 250ml, with an embedded glass vessel with vol. of 1lit. was used for decolorization of the purified date juice by resin and decolorization was done by absorbing resins (Purosorb PAD 900, England).

*Purification and Decolorization of Date Juice by Commercial Thechnique:*

To purify the raw date juice by the industrial method by gelatin-bentonite, 200ml of the raw juice was poured in a 500ml erlen. Bentonite is processed only when it is watery, thus it should be soaked for some time before being used. Hence, the bentonite solution 20% of sodium-calcium (Germany) was prepared 8-12hrs. before the experiments and then 25g per lit. of the 20% solution was added into the erlen. Raw juice and bentonite mixture were blended for 15min. by Jenway Magnetiv hotplate (U.S.A), in low revolution and in 60˚C. Then, 0.03g/lit. of gelatin (type: A) was added to the mixture and after stirring it for 10min. in the ambient temperature, the date extract was filtered by paper filters. Active carbon was used tor decolorization (0.2% of solid material in the extract solution of 0.07g/ml.).

The rate of adsorption in wavelengths of 420 and 560nanometer was recorded by Lambada spectrophotometer (Milton Roy, Lambada 25 UV/Visible, USA), and the rate of pigmented colors were calculated by ICUMSA method (existing in national Iranian standards- No. 69) (Institute of

Standards and Industrial Research of Iran. 1999). Also , the rate of turbidity was measured by HANA turbidity measure (HANNA HI9370,USA- Made in Japan).

**Results and discussion**

*The Effect of Purification Methdo on the Rate of Turbidity of Date Juice*

The effects of liming-phosphatation and gelatin-bentonite purification methods on the rate of turbidity of date juice is shown in fig. 1. The results from this study showed that using liming-phosphatation method reduces turbidity of date juice by 98%, while using gelatin-bentonite reduces turbidity by 40%.

**Table 1.** The amount of date juice reduce sugar after purification and decolorization in two different methods, "a" and "b".

| Heavy metals | Existing amount in date juice "a" | Existing amount in date juice "b" | Acceptable range |
|---|---|---|---|
| Arsenic | 8 ppb | 35 ppb | 300 ppb |
| Lead | 21 ppb | 60 ppb | 300ppb |
| Copper | 1410 ppb | 4000 ppb | 5000 ppb |

Liming causes sedimentation of some non-sugared substances and instability of colloid compositions such as pectin, dextran, and proteins. Due to their high molecular weights, these compositions provide problems in purifying the date juice, being considered among the factors in turbidity (Niazmand, 2007). In the phosphatation stage, the produced calcium octa-phosphate with positive load that is from the reaction of lime with phosphoric acid is mixed with negative-load colloids via electrostatic absorption and is removed from the ambient after filtering. In this way, the turbidity is reduced (Liese *et al.*, 2006).

**Table 2.** The amounts of heavy metals in date extract after purification and decolorization by two different methods; a: Liming-phosphatation and resin and b: Gelatin- bentonite and active carbon.

| Sugar compound | Amount in date juice | Amount in "a"extract | Amount in "b" extract |
|---|---|---|---|
| Glucoce (in 100g of soluble solid materials) | 50 | 50 | 49 |
| Fructose (in 100g of soluble solid aterials) | 48 | 48 | 46 |
| Sucrose(in 100g of soluble solid materials) | 09 0/ | 0/06 | 0/03 |
| Soluble solid material (in 100g of date juice) | 37.02 | 37.46 | 37 |

In justifying the reduction of turbidity of the extract by gelatin-bentonite method, it can be said that bentonite poly-phenol oxidase absorbs phenols and positive-load molecules *via* electrostatic absorption and some no-load molecules *via* adsorption. Bentonite only requires some minutes for reacting with peptides and proteins and gelatin could be used to help the effect of accumulation of impurities by bentonite to be effective in increasing compaction of bentonite sedimentation. Gelatin is a protein with positive load and links with the negative-load types such as tannin and bentonite, making a compact sedimentation with the soluble proteins to facilitate clearing aspect (Liese *et al*., 2006; Niazmand, 2007). The results of this research show that liming-phosphatation method has better effects as compared to purification by gelatin-bentonite method, due to coagulation of colloid compositions and adsorption of

coagulated material by calcium phosphate. The reason for that could mainly be due to increased adsorption of produced calcium phosphate as compared to the adsorption of gelatin-bentonite and hence, eliminating relevant colloid compositions.


**Fig. 1.** The effects of "a" liming-phosphatation and "b" gelatin-bentonite purification methods on the rate of turbidity of date juice.

*Effet of Decolorization Method on the Rate of Date Extract Color, in the Wavelength of 420 Nanometer*

The effect of absorbing resins (Purosorb PAD 900) and active carbon on the rate of decolorization of date juice in 420 NM wavelength is shown in fig. 2. The findings indicate more decolorization of the absorbing resin in this wavelength as compared to decolorization by active carbon.

Alkaline dissolution of glutamic acid and aspartic acid existing in date juice is occurred relatively in the liming stage, completed in the evaporation and condensation stage. One of the products resulted from this dissolution is pyrrolidone carboxylic acid that its formation reduces pH in the extract. Also, the secondary product of this process is ammonia that enters into the condensed water of the evaporator walls during condensation process (DeMan, 1999). In reaction to non-enzyme browning, γ-aminobutyric acid is produced from pyrrolidone carboxylic acid by forming 2- pyrrolidone as an intermediate product, having a high rated activity to participate in Millard reaction. Thus, elimination of such prerequisite compositions of colors and anthocyanin compounds existing in date juice due to their instability in alkaline conditions during liming reveal the importance and effectiveness of this method as compared to gelatin-bentonite method (Eski, 2000; Liese, 2006).

In contrast to anthocyanin compounds that are sensitive to alkaline conditions, carotenoids do not face a great deal of change during alkaline purification (Gould *et al.*, 2009). Thus, they enter the decolorization stage almost with no changes. Colored compounds produced during Millard reaction in date juice are mainly resulted from the reaction between furfural and proline amino acid. Thus, active carbon could absorb colored compounds produced in Millard reaction via electrostatic absorption with negative-load pigments (DeMan, 1999).

PAD900 resin is one in the group of non-ion absorbent resins, lacking active groups with high adsorption (800m²/g) that could eliminate some non-ionized colored compounds in date juice, including carotenoids. Although active carbon is a powder with rather smaller particle diameter (1200m²/g) than PAD900 resins, but it does not show high capability in eliminating colored compounds due to using less amounts of it (about 0.07g/100ml) (Loghmani *et al.*, 1391).

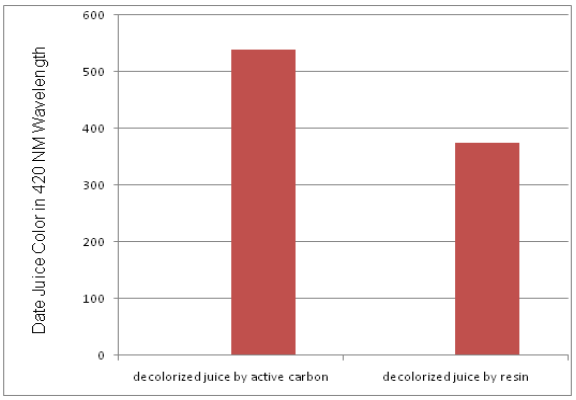


**Fig. 2.** The effect of absorbing resins (Purosorb PAD 900) and active carbon on the rate of decolorization of date juice in 420 NM wavelength.

*Effect of Decolorization Method and Purification on the Amounet of Carbohydrates of Date Extract*

The amount of date juice reduce sugar after purification and decolorization in two different methods is indicated in table 1. The method of purification with lime and phosphoric acid and

decolorization with absorbed resin is shown with "a" and purification with gelatin- bentonite and decolorization with active carbon is shown with "b". The findings show that the amount of reduce sugar has not changed in "a", while the rate of glucose, fructose and sucrose in "b" has reduced 2%, 4% and 60%, respectively. Regarding the conditions in which invert sugar is dissolved (85˚C and pH=12.3), it seems that the most important factor in reducing sugar compounds during purification stage by liming-phosphatation and decolorization by absorbing resin is absorption by absorbing resin "PAD900".

*The Effect of Decolorization Method and Purification on the Rate of Heavy Metals in Date Extract*

The amounts of heavy metals in date extract after purification and decolorization by two different methods are shown in table 2. The acceptable rates of heavy metals is defined according to Iranian national standards, No. 5075, according to which the decolorized juice by active carbon has higher values of heavy metals relative to that by the absorbing resin. The rate of copper is herewith considerable. Regarding the obtained results, it can be concluded that decolorization by absorbing resin is preferred for health purposes as compared to using active carbon (Sarkar, 2011).

## Conclusion

According to the results from the studies, it can be said that alkaline purification of date juice preserves date juice sugar, and prevents darkening of the color of date juice by eliminating the participating factors in Millard reaction. Moreover, high capability of resins in eliminating heavy metals as compared to active carbon is an important factor for health and food security.

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