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Quality characteristics and consumer acceptance of soft drinks manufactured by clarified date liquid sugars

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Abstract. This study was carried out to determine the effect of replacement of granular sucrose by clarified date liquid sugars during manufacture of soft drinks. In order to obtain pure liquid sugars, date syrup obtained by hot extraction (85 °C for 2h) at 20 % was clarified by Bentonite at concentration of 16.6 g.L^{-1}, temperature of 60 °C for 30 min at pH 4. The sweetened clarified date syrup was concentrated in water bath at 105 °C, sterilized at 120 °C for 10 min and used for replacement of sucrose at 20, 40 and 80 mL. The clarification of date syrup by Bentonite removes the major compounds except the sugars and leads to clear sweetened liquid sugars. Clarified liquid sugars was characterized by lower levels of turbidity 22.0±0.2, viscosity 0.93±0.01 mPas, density 1.001±0.020, optical density 0.40±0.01, pectin 0.70±0.10 %, dry matter 14.76±0.20 %, proteins 0.07±0.10 %, ash 0.19±0.01 % and higher amounts of sugars 84.2±0.2 %. The inclusion of liquid sugar for manufacture of soft drinks as substitute of sucrose found a good physical, biochemical and microbiological qualities and high acceptability for its sensorial characteristics. These results suggest the potential use of date liquid sugars for formulation of new food products.

Keywords: bentonite, clarification, date, liquid sugar, soft drinks, syrup.

Introduction

Date palm (*Phoenix dactylifera* L.) belonging to the Arecaceae family represent the important arboricultural crop of the arid and semiarid regions of the world [SAWAYA *et al.,* 1983]. The fruit is composed of a seed and fleshy pulp which constitutes between 85–90% of date fruit weight [HUSSEIN *et al.,* 1998]. Internal part of date fruit is rich in sugars, fibers, proteins, pectin, lipids, mineral salts, vitamins and bioactive components such as anthocyanins, procyanidins, phenolics, and flavonoids which offer protection against oxidative stress [AL–FARSI *et al.,* 2005].

The varietal structure of the Algerian palm dates provides varieties of high quality and excellent commercial value destined to the export and local consumption (*Deglet–Nour*). Other varieties known as common dates (*Hmira*) are low market grade do not meet the minimum quality attributes for direct use and have been used as raw materials of fermentation industry or animal feed for many years [AHMADNIA and SAHARI, 2008]. The non–use of this by–product for human food constitutes a real economic loss.

Recently, innovative date by–product are being developed aiming at producing value added products of higher nutritional value. However, the production of high nutritional quality sweeteners from date by–products for sucrose substitution in food formulations is a prime target.

Dates have been used in several food preparations in order to replace added sugar. Date was used in the preparation of yoghurt in the form of syrup [GAD *et al.,* 2010], fiber [HASHIM *et al.,* 2009] and powder [HARIRI *et al.,* 2018] and for the preparation of soft drink in the form of powder [HARIRI *et al.,* 2017].

However, the qualities, especially texture and colour of reformulated products, were affected. All these date by–products are in liquid state with different physical properties to sucrose and its application in food production faces major difficulties. These are due to the high viscous liquid like state of date by–products causing operational and technological challenges for their packaging, transport, handing, piping and mixing with other ingredients.

Moreover, the inclusion of high viscous date by–products into food such as yoghurt or soft drink is likely to change activity of starter culture, solubility of carbonic gas and final product quality.

Date syrup is the most valuable commonly derived date product; it can be obtained after removing the colloidal materials and bulk of dyestuff from extract [ELLEUCH *et al.*, 2008]. Date liquid sugar can be produced from date syrup after extraction, purification and also remove the pectin compounds, protein, fiber and dyes [AL–FARSI, 2003]. Date liquid sugars, until now, have been not used in food formulations.

To our knowledge, this is the first study to valorize this natural sugar which is marked by a good nutritional value. It is characterized by high amounts of sugars, good aroma, colour and taste.

This clarified by–product due to it purity can be used as an ingredient of choice for the many food formulations such as soft drink, and can be enhance the qualities of the reformulated products compared to the utilization of the other date derivates.

This study aimed to investigate the influence of substitution of sucrose by liquid sugars on the same qualities of soft drink.

Material and methods

Vegetable material. The date fruits variety *Hmira* at the tamr stage of maturity was harvested in the month of September 2017 from the region of Bechar (South–West of Algeria). The choice of this badly exploited variety was based on its availability, low cost and its richness in sugars.

Natural adsorbent. The natural clay used was obtained from the Maghnia deposit (West of Algeria) by national fat firm from the region of Sig (Mascara, West of Algeria).

This bentonite ready to use presented in the form of powders was used for the bleaching of edible oils.

This clay is a silicate hydrates that contain quartz as the major impurity, and 85 % of montmorillonite. This clay is a sodium bentonite with the following characteristics: pH 6.2, specific area 80 $m^2.g^{-1}$, calcium (Ca^{2+}) 30.6 $meq.100g^{-1}$, magnesium (Mg^{2+}) 12.8 $meq.100g^{-1}$, sodium (Na^+) 36.2 $meq.100g^{-1}$ and potassium (K^+) 9.5 $meq.100g^{-1}$.

This adsorbent presents a strong capacity for ion–exchange, a colloidal property, and a maximum capacity for adsorption of organic matters and mineral elements.

Chemicals substances. All chemicals and solvents were purchased from Sigma Aldrich (Munich, Germany), unless otherwise specified.

Extraction and clarification of date fruit syrup.

One liter of distilled water at 80–85 °C was added to 200g of edible date fruit (cut into small pieces to increase the surface of diffusion) during 2h, homogenized with a mixer Ultra–Turrax T25 (IKA–Werke GmbH, Germany) and filtered through a cloth.

The collected syrup was centrifuged for 10 min at 15000 rpm (Sigma labrzentrifugen D–37620 Osterode am Harz, Germany) and left standing for 48h at room temperature to precipitate large quantities of insoluble substances and then filtered. The final date syrup was gone through the non–deposit phase of Watman filter paper (N°45).

To obtain pure liquid sugars by clarification of date fruit syrup, several preliminary tests were applied.

The clarification of date palm syrup was performed under some optimized conditions (concentration of the bentonite 16.6 $g.L^{-1}$, temperature 60 °C for 30 min at pH 4). The bentonite and date syrup were mixed by the magnetic blender in a low speed and the mixture was centrifuged at 4500 rpm for 7 min.

The sweetened clarified syrup was concentrated in water bath at 105 °C until a viscous, clear, dark colored product was obtained.

Physicochemical and biochemical analyzes of the date syrups (before clarification) and liquid sugars (date syrup after clarification) were determined.

Physic–biochemical characterization of the date palm syrups and liquid sugars.

All samples were analyzed chemically according to the official methods of analysis described by the Association of Official Analytical Chemist [AOAC, 2007]. The pH was measured using a digital pH meter apparatus (Mettler Toledo. MP220) and viscosity was evaluated by using the drop bile viscometer (HAAKE). The turbidity was quantified by a turbidimeter Hana HI9370 model, America and the density was determined at 25 °C by weighing the sample contained in a 25 mL pycnometer using a four digits Sartorius–GE412 balance, Germany [JAGANNADHA–RAO *et al.*, 2009].

To determine the optical density, 50 mL of diluted samples were centrifuged at 2300 rpm for 20 min. 25 mL of the supernatant was mixed with equal volume of 95% ethanol and then filtered.

The optical density was measured using UV/Vis spectrophotometer model Hitachi 4–2000 at 420 nm [GARZA *et al.*, 1999]. The dry matter content was calculated after evaporation of the water present in the test sample placed in an oven 105 °C for 24h (SPAG, Massy, France) until constant mass was obtained.

Total nitrogen was determined by Kjeldahl method, then the protein content was calculated using a factor of 6.25 [AOAC, 2007]. Total sugars were quantified at 480 nm by Dubois method [DUBOIS *et al.*, 1956]. Standards were prepared with different concentrations of glucose solutions. The ash content was evaluated according to the AOAC official method 972.15 by incineration 5 grams of test sample in a muffle furnace (Nabertherm, Germany) at 600 °C for 3 h [AOAC, 2007].

To determine the pectin content, 10g of the sample (noted M) was mixed under stirring with 10 mL of 10 % NaOH. After standing for 5 min, 4 to 8 mL of 5N HCl (37 % of purity) were added and the mixture was heated for 5 min then filtrated. The capsule was placed in an oven 105 °C until constant mass was obtained and noted (P1). After drying, the sample was introduced in a muffle furnace at 700 °C; we noted a further weight (P2). The percentage of pectin was calculated by the following formula:

$$\text{Pectin}\ \% = \frac{\text{P1} - \text{P2}}{\text{M}} . 100$$

For all these measurements, three replicates per sample were made and their respective average was taken.

Integration of liquid sugar in soft drinks

The clarified liquid sugar was used after sterilization at 120 °C for 10 min at different volumes to cover a wide range of application from soft drink and the comparison was made against sucrose solutions. A soft drink control (SDC) was prepared by dissolving 125g of sucrose, 0.75g of citric acid and 1.5 mL of aroma in 250 mL water. Samples were prepared by total replacing of sucrose by 20 mL of liquid sugar (SD20), 40 mL (SD40) and 80 mL (SD80).

Liquid sugar contains significant amounts 84% of total sugars consisting essentially of sucrose, glucose and fructose. These are endowed with a very higher sweetening power compared to the sucrose. The amount of sucrose used in the control soft drink is 124 g in 250 mL (sucrose represent 50 g.100 mL^{-1}). Increasing volumes of liquid sugars ranging from 20, 40 and 80 mL have been tested to avoid altering taste and aroma.

All samples underwent the following stages of manufacture: bottle washing, adding ingredients, filtration for tests, injecting carbonated water, capping and storage at 4 °C.

All the samples were evaluated for proximate composition, microbiological and sensory characteristics.

Physicochemical parameters of all soft drinks were determined by measurement of pH using a pH–meter and determination of titratable acidity (TA).

The TA was evaluated by manual titration of 10g of sample with standardized 0.1N NaOH using phenolphthalein as indicator.

The volume of NaOH required to neutralize the soft drink was recorded and used to calculate the content of titratable acids. Biochemical characteristics of soft drinks were evaluated by determination of the total sugars by Dubois method, ash content by incineration and total solid level.

The microbiological quality was evaluated by enumeration of total plate count (TPC) in the TGEA (Triptone Extrat Glucose Agar) after incubation at 30 °C for 72h [RIKKA *et al.*, 2011]. All colonies were counted on those plates containing 30–300 colonies and multiplied by dilution factor. Arithmetic average was counted as TPC per milliliter. Total and fecal coliforms were counted respectively in desoxycholate lactose agar and violet red bile lactose agar after incubation for 24 to 48h at 37 °C for total coliforms and at 44 °C for faecal coliforms [TRIBST *et al.*, 2009].

Faecal streptococci were quantified in Roche presumptive medium supplemented by sodium azohydrate and Litsky confirmation medium supplemented by sodium azohydrate and purple ethyl. *Staphylococcus aureus* was counted on Giolitti Cantonii and Chapman agar after incubation for 24 to 48h at 37 °C.

Salmonella was evaluated in *Salmonella* agar medium incubated for 24 to 48h at 37 °C, after enrichment in Selenite–F Broth (SFB). Search sulfite–reducing *Clostridium* can be done by counting the sporulated forms which develop in media Meat Liver containing sodium sulphite and iron alum after incubation for 48h at 37 °C.

The yeasts and moulds were quantified on potato dextrose agar (PDA) supplemented by oxytetracycline after incubation for 5 days at 25 °C. All colonies were counted on the plates containing less than 50 colonies and multiplied by dilution factor.

To determine the acceptability of the soft drinks, all samples were evaluated for sensory characteristics by 10 panelists (students and technicians from University of Mascara, Algeria); using a point scale 5: good, 3: acceptable, 1: bad [METIN, 2006]. The selected trained participated in the evaluation and they were asked to fill in a questionnaire which included the following questions for the taste, color, acidity, and odor.

Panelist were informed and agreed to taste the sample before the tests, and they were informed of the type of product being tested and asked about their soft drink consumption habits.

Tap water was provided between samples to cleanse the palate.

Statistical analysis

All analyses were done in triplicate and the data were statistically evaluated by analysis of variance ANOVA by applied the level of significance ($P \leq 0.05$) using Microsoft excel 2010 and SPSS Statistics software 8.1.

Results and discussion

Characterization of the date palm syrups and liquid sugars

The different steps of clarification significance $P \leq 0.05$ remove the major compounds except the sugars. The pH of the dates palm syrup extracted was 5.26±0.03. This value was higher to 4.91 and 4.24 reported respectively by [EL–SHARNOUBY *et al.*, 2014] and [FARAHNAKYA *et al.*, 2016a].

After clarification, the pH of the liquid sugar decreases to 4.00±0.02. This decrease can be attributed to the regulation of pH during clarification process.

The viscosity and density of the date syrup were respectively 1.90±0.01 mPas.s and 1.06±0.03; these higher values can be attributed to the richness of the syrup in high molecular weight organic compounds such as pectin, tannins, colloidal and suspended materials responsible for the turbidity.

These substances affect the purity and therefore increase the viscosity. The nature of sugars in these syrups might have some contribution for high viscosity [JUNK and PANCOAST, 1973].

The clarified liquid sugar presents significantly very lower values of viscosity 0.93±0.01 mPas.s and density 1.001±0.020 due to the elimination of these compounds.

The reactions of polymerization and browning that produce polymers and colored substances provide to the products a darker tint, the more often brown or black. The results were given in the table 1.

Table 1.
Physico–biochemical characteristics of the date palm syrup and liquid sugars (values represent Mean ± SD; n=3; Confidence level *P≤0.05*)

Characteristics \ Samples	Date palm syrup	Liquid sugars at pH 4
pH	5.26±0.03	4.00±0.02
Viscosity (mpas.s)	1.90±0.01	0.93±0.01
Density	1.060±0.030	1.001±0.020
Optical Density	0.47±0.02	0.40±0.01
Turbidity (NTU)	> 1000	22.0±0.2
Dry matter (%)	47.98±0.30	14.76±0.20
Ash (%)	0.38±0.02	0.19±0.01
Proteins (%)	4.10±0.20	0.07±0.10
Pectin (%)	35.45±0.30	0.70±0.10
Total sugars (%)	16.9±0.3	84.2±0.2

Elleuch and collab. reported that the sugars and proteins loss in date by–products could be explained by non-enzymatic browning during storage (Maillard reaction) and rinsing of date flesh samples [ELLEUCH *et al.*, 2008]. The higher value of the optical density of the date syrup 0.47±0.02 was in line with the work of El–Nagga and Abd El–Tawab [EL–NAGGA and ABD EL–TAWAB 2012]. After clarification, a slightly decrease of the optical density 0.40±0.01 was observed. This data is not in line with the work of [JALALI *et al.*, 2014].

The author's showed that with the decreased pH from 6 to 4, the absorbance's rate of substances responsible for colour of the date syrup was increased by bentonite and gelatin. In the investigations which performed by Shen and collab. and Li and collab. about the adsorption of anionic dyes by bentonite, they concluded that the elimination of these substances is increased by decreasing pH [SHEN *et al.*, 2009, LI *et al.*, 2010].

Date flesh and date palm syrup are a good source of dietary fiber and total phenolics compunds [EL–NAGGA and ABD EL–TAWAB, 2012].

The date syrup has a very higher value of turbidity (over to 1000 NTU) due according to Junk and Pancoast to the presence of large particles in colloidal suspension (total dietary fiber, pectin, polyphenolic compounds, coloured pigments, etc.), substituted during hot extraction [JUNK and PANCOAST 1973].

During this operation, pectin combines with proteins and provokes the highness of turbidity. After clarification, there was a strong significance decrease of the turbidity to 22.0±0.2. The decreasing turbidity of the date syrup by clarification leads to a clear liquid sugars.

According to Bouhlali and collab., the date fruit contains higher amount of sugars (66.03–83.05 dry weight) but a lower content of fat (0.218–0.363 % DW), protein (2.20–3.45 % DW) and predominance of potassium, calcium and magnesium [BOUHLALI *et al.*, 2017].

The protein content of date syrup was 4.10±0.20 %, this data are higher to those cited by several authors in date syrup obtained by different methods of extraction [EL–NAGGA and ABD EL–TAWAB, 2012; EL–SHARNOUBY *et al.*, 2014; FARAHNAKY *et al.*, 2016a]. After physical clarification, the liquid sugars presents total proteins of 0.07±0.10%. A part of the amino acids has waste groupings acidic or basic who are not involved in the peptide binding and which confers to the molecule the amphoteric character.

The algebraic sum of the charges brought by a protein was its net charge which becomes zero at the pHi (isoelectric pH). At the pHi, the proteins will not be retained by the natural material clarifying used.

At pH 4 (point very remote from the pHi), the proteins were retained by the Bentonite and were not eluted which explains the lower values of protein and turbidity obtained.

The level of pectin was 35.45±0.30% in untreated date syrup. The hot extraction of date palm syrup (80–95°C) causes the destruction of the cell walls of the date and consequently the maximum release of pectin.

At pH 4, value remote to the pHi which explains the lower quantity of the pectin 0.70±0.10 remaining after clarification. It's well known that losses of high molecular weight constituents, such as pectin and starch, occur in the clarification processes [MAKHLOUF–GAFSI *et al.*, 2016].

According to the obtained results, it was found that the dry matter evolves from 47.98±0.30 % for untreated date syrup to 14.76±0.20 for clarified syrup.

This significance difference can be attributed to the operations of clarification and concentration. This data is in same line with the value reported by El–Nagga and Abd El–Tawab [EL–NAGGA and ABD EL–TAWAB 2012, CAUNI *et al.*, 2016].

The obtained results showed that the date syrup contain considerable amounts of mineral salts 0.38 ± 0.02%. Our results are not in line with the results cited by Farahnakya and collab., who reported that the date syrup has 2.23% [FARAHNAKYA *et al.*, 2016a]. After physical treatment, the liquid sugars displayed ash content in the order of 0.19±0.01%.

This significance lower value can be explained by the purification process and removing of minerals, other insoluble compounds and impurities. The filtration and defecation allow to eliminate a part of the mineral salts and the other part was inserted in the inter space leaf of the adsorbent. This result is in some line with the results of El–Nagga and Abd El–Tawab [EL–NAGGA and ABD EL–TAWAB 2012] and Jalali and collab., [JALALI *et al.*, 2014]. The author's showed that with deceasing pH, the ash content of syrup has a decreased.

It is well known that dates are important sources of sugars with dominance of glucose and fructose.

The obtained results showed that the date syrup presents total sugars of 16.9±0.30%. Similar results were found with other varieties of dates by Al–Farsi and collab. [AL–FARSI *et al.*, 2007].

Our results are not in line with the results obtained by Farahnakya and collab., and Makhlouf–Gafsi and collab., who reported that the date syrup have 80 % of carbohydrates (39.63 % glucose, 33.68 % of fructose and 1.25 % of sucrose) [FARAHNAKYA *et al.*, 2016b, MAKHLOUF–GAFSI *et al.*, 2016]. This difference can be attributed to the variety of date used and concentration of date syrup. After clarification and concentration, the results indicate a significance very higher value of total sugars in the order of 84.2±0.2.

The clarification has allows an elimination of substances other than sugars constituting the dry matter and the treatment of concentration eliminate the fractions of the free water. A similar result 81.88 % obtained in liquid sugar was reported by El–Sharnouby and collab., [EL–SHARNOUBY *et al.*, 2014].

Potential use of liquid sugar in soft drinks

As shown in table 2, all soft drinks have lower values of pH due according to Bassiouny and Yang to the addition of the citric acid and CO_2 [BASSIOUNY and YANG, 2005].

Similar results were obtained by Lin and collab., and Amos–Tautua and collab., [LIN *et al.*, 2003, AMOS–TAUTUA *et al.*, 2014]. The acidity content increases significantly in the treated soft drinks due to the acidic pH of the liquid sugars.

The total solid content of the control soft drink was 9.40±0.10%; the replacement of sucrose by 20 mL of liquid sugars causes' slightly decreases of the total solids 7.13±0.20.

This decrease can be attributed to the high-water content compared to the sucrose. The addition of 40 and 80 mL of liquid sugars found a total solid content respectively of 9.12±0.10 and 11.30±0.20%.

These values were higher to the solid content of soft drinks treated in previous study by date powders [HARIRI *et al.*, 2017, SAMFIRA, *et al.*, 2015]. The total sugars content of the SDC was 9.82±0.10, the replacement of sucrose by all volumes of the liquid sugars improves significantly the nutritional quality of the soft drinks due to the richness of liquid sugar in sucrose, glucose and fructose.

The amount of sugars in all treated soft drinks was higher to the quantity of sugars obtained in soft drink characterized by addition of date powders variety *H'lowa* in previous study [HARIRI *et al.*, 2017, BUTU, *et al.*, 2014, BUTNARIU, 2016].

Table 2.

Physico–biochemical and microbiological characteristics of the soft drinks (values represent Mean ± SD; n=3; Confidence level *P≤0.05*; SDC: soft drink control; SD20: soft drink with 20 mL of liquid sugar; SD40: soft drink with 40 mL of liquid sugar; SD80: soft drink with 80 mL of liquid sugar)

Characteristics \ Soft drinks	SDC	SD20	SD40	SD80
pH	4.13±0.20	4.17±0.30	4.19±0.10	4.21±0.10
Acidity	7.0±0.3	26.0±0.1	23.0±0.2	21.0±0.1
Total Solid Content (%)	9.40±0.10	7.13±0.20	9.12±0.10	11.30±0.0
Ash (%)	0.11±0.02	0.10±0.01	0.13±0.03	0.14±0.01
Total sugars (%)	9.82±0.10	11.30±0.30	11.80±0.0	11.80±0.0
Total Plat Count (germs.mL^{-1})	7.1×10^3	7.0×10^3	7.2×10^3	7.0×10^3
Yeasts and moulds (germs.mL^{-1})	4.1×10^3	4.2×10^3	4.1×10^3	4.1×10^3

Similar percentages of ash were obtained for all samples of soft drinks due to the poverty of liquid sugars in ash removed by clarification. These values were lower to the soft drinks treated by date powders due to the richness of date powders in mineral salts [HARIRI *et al.*, 2017].

From the obtained results, it was clear that all soft drinks contain a significant amount of total viable count ranged from 7.1×10^3 germs.mL^{-1} for SDC to 7.2×10^3 germs.mL^{-1} for SD40. The average yeasts and moulds range from 4.1×10^3 germs.mL–1 for SDC to 4.2×10^3 germs.mL^{-1} for treated soft drinks. Our results are in agreement with the results obtained by Khan and collab [KHAN *et al.*, 2015] and lower to the number of TPC, yeast and moulds obtained in soft drinks treated by date powders in previous study [HARIRI *et al.*, 2017]. The lower value of pH greatly limits the number and the type of bacteria that can survive or growth [PRESCOTT *et al.*, 2002, SAMFIRA, *et al.*, 2015, RASHED and BUTNARIU, 2014].

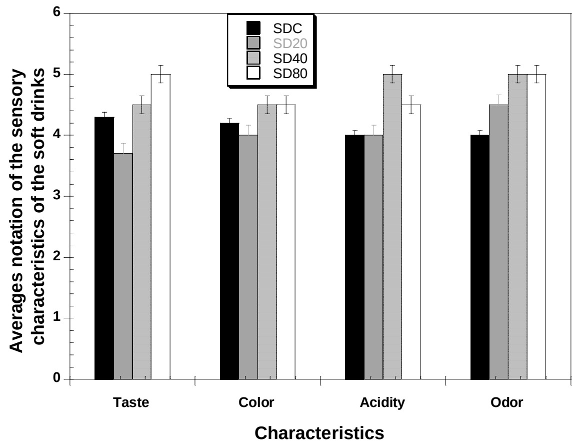

Figure 1. Average notation of the sensory characteristics (taste, color, acidity and odor) of the control soft drink (SDC) and treated soft drinks by 20, 40 and 80 mL of liquid sugars (SD20, SD40 and SD80). Values represent Mean ± SD; n=3; Confidence level *P≤0.05*

The results showed the total absence of total and fecal coliforms, *Salmonella*, *Staphylococcus aureus*, sulfite–reducing *Clostridium*, and Faecal streptococci. The water used during the preparation was likely to provide possible sources of additional bacterial contamination [BRYAN *et al.*, 1998, PETRACHE, *et al.*, 2014, BUTNARIU, *et al.*, 2016].

Furthermore, these soft drinks were left in ambient temperature which may have led to the proliferation of contaminating bacteria resulting in increased bacterial counts [BRYAN *et al.*, 1998].

Spoilage of soft drinks is caused by a limited number of yeasts, moulds and acid tolerant bacteria. Spoilage effects include formation of clouds, particulates, taints and excessive gas. Figure 1 show the results obtained for the sensory analysis carried out of the assays.

The replacement of the sucrose by 40 and 80 mL of liquid sugars improves significantly the color, taste, acidity and odor of the soft drinks.

Conclusions

Elaboration of liquid sugars from date syrup can extend the usage of date by–products as substitutes for sucrose as a sweetener in many foods preparations.

Date liquid sugars produced by clarification of date syrup using a bentonite as a natural adsorbent found a by–product with high content of sugars.

The use of liquid sugar for manufacture of soft drinks as substitute of sucrose found a good quality with good biochemical, microbiological and sensory characteristics. These results suggest that there is potential for liquid sugars of date palm for formulation of new food products.

References

1. Ahmadnia, A.; Sahari, M.A. Using date powder in formulation of chocolate toffee. *Iranian Journal of Food Science and Technology,* **2008**, 5(3), 1–8.
2. Al–Farsi, M.; Alasalvar, C.; Morris, A.; Baron, M.; Shahidi, F. Compositional and sensory characteristics of three native sun–dried date (*Phoenix dactylifera* L.) varieties grown in Oman. *Journal of Agricultural and Food Chemistry,* **2005**, 53(19), 7586–7591.
3. Al–Farsi, M.; Alasavar, C.; Al–Abid, M.; Al–Shoaily, K.; Al–Amry, M.; Al–Rawahy, F. Compositional and functional characteristics of dates, syrup, and their by–products. *Food Chemistry,* **2007**, 104(3), 943–947.
4. Al–Farsi, M.A. Clarification of date juice. *International Journal of Food Science and Technology,* **2003**, 38, 241–245.
5. Amos–Tautua, W.; Bamidele, M.; Diepreye, E.R.E. Ultra–violet spectrophotometric determination of caffeine in soft and energy drinks available in Yenagoa, Nigeria. *Advance Journal of Food Science and Technology* **2014**, 6(2), 155–158.
6. AOAC, 2007. Official methods of Analysis of AOAC international, 2007. Gaithersburg. Maryland.
7. Bassiouny, M.A.; Yang, J. Influence of drinking patterns of carbonated beverages on dental erosion. *Gen Dent,* **2005**, 53(3), 207–210.
8. Bouhlali, I.E.T.; Ramchoun, M.; Alem, C.; Ghafoor, K.; Ennassir, J.; Zegzouti, Y.F. Functional composition and antioxidant activities of eight Moroccan date fruit varieties (*Phoenix dactylifera* L.). *Journal of the Saudi Society of Agricultural Sciences,* **2017**, 16, 257–264.
9. Bryan, F.L.; Michanie, S.C.; Alvarez, P.; Paniagua, A. Critical control points of street vended foods in the Dominican Republic. *Journal of Food Protection,* **1998**, 51(5), 373–383.
10. Butnariu M. Methods of analysis (extraction, separation, identification and quantification) of carotenoids fromnatural products. *Journal of Ecosystem & Ecography*, **2016**;6:193.
11. Butnariu, M.; Sarac, I.; Pentea, M.; Samfira, I.; Negrea, A.; Motoc, M.; Buzatu, A.R.; Ciopec, M. Approach for Analyse Stability of Lutein from *Tropaeolum majus*, *Revista de chimie*, **2016**, 67(3), 503–506.
12. Butu, M.; Butnariu, M.; Rodino, S.; Butu, A. Study of zingiberene from *Lycopersicon esculentum* fruit by mass spectometry, *Digest journal of nanomaterials and biostructures*, **2014**, 9(3), 935–941.
13. Caunii, A.; Butu, M.; Rodino, S.; Motoc, M.; Negrea, A.; Samfira, I.; Butnariu, M.

Isolation and Separation of Inulin from *Phalaris arundinacea* Roots, *Revista de chimie*, **2015**, 66(4), 472–476.
14. Dubois, M.; Gilles, K.A.; Hamilton, J.K.; Rebers, P.A.; Smith, F. Colorimetric method for determination of sugars and related substances. *Analytical Chemistry,* **1956**, 38(3), 350–356.
15. Elleuch, M.; Besbes, S.; Roiseux, O.; Blecker, C.; Deroanne, C.; Drira, N.E.; Attia, H. Date flesh: Chemical composition and characteristics of the dietary fiber. *Food Chemistry,* **2008**, 111, 676–682.
16. El–Nagga, E.A.; Abd El–Tawab, Y.A. Compositional characteristics of date syrup extracted by different methods in some fermented dairy products. *Annals of Agricultural Sciences,* **2012**, 57(1), 29–36.
17. El–Sharnouby, G.A.; Aleid, S.M.; Al–Qtaibi, M.M. Liquid sugar extraction from date palm (*Phoenix dactylifera*) fruits. *Journal of Food Processing and Technology,* **2014**, 5(12), 1–5.
18. Farahnakya, A.; Mansoorib, N.; Majzoobia, M.; Badii, F. Physicochemical and sorption isotherm properties of date syrup powder: Antiplasticizing effect of maltodextrin. *Food and Bioproducts Processing,* **2016b**, 98, 133–141.
19. Farahnakya, A.; Mardani, M.; Mesbahi, G.H.; Majzoobi, M.; Golmakani, M.T. Some Physicochemical properties of date syrup, concentrate, and liquid sugar in comparison with sucrose solutions. *Journal of Agricultural Science and Technology,* **2016a**, 18(3), 657–668.
20. Gad, A.S.; Kholif, A.M.; Sayed, A.F. Evaluation of the nutritional value of functional yogurt resulting from combination of date palm syrup and skim milk. *American Journal of Food Technology,* **2010**, 1–10.
21. Garza, S.; Ibarz, A.; Pagan, J.; Giner, J. Non–enzymatic browning in peach puree during heating. *Food Research International,* **1999**, 32(5), 335–343.
22. Hariri, A.; Ouis, N.; Bouhadi, D. Effect of substitution of sugars by date powders variety H'lowa on the qyality of the soft drinks. *Journal of Applied Biotechnology and Bioengineering,* **2017**, 3(6), 1–8.
23. Hariri, A.; Ouis, N.; Bouhadi, D.; Benatouche, Z. Characterization of the quality of the steamed yoghurts enriched by date flesh and date powder variety *H'loua*. *Banats Journal of Biotechnology,* **2018**, IX(17), 31–39.
24. Hashim, I.B.; Khalil, A.H.; Afif, H.S. Quality characteristics and consumer acceptance of yoghurt fortified with date fiber. *Journal of Dairy Science,* **2009**, 92(11), 5403–5407.
25. Hussein, A.S.; Alhadrami, G.A.; Khalil, Y.H. The use of dates and date pits in broiler starter and finisher diets. *Bioresource Technology,* **1998**, 66, 219–223.
26. Jagannadha–Rao, P.V.; Das, M.; Das, S.K., Changes in physical and thermo–physical properties of sugarcane, palmyra–palm and date–palm juices at different concentration of sugar. *Journal of Food Engineering,* **2009**, 90(4), 559–566.
27. Jalali, M.; Jahed, E.; Haddad Khodaparast, M.H.; Limbo, S.; Mousavi Khaneghah, A. Evolution of bentonite and gelatin effects on clarification of variety of date fruit Kalutech juice with response surface methodology. *International Food Research Journal,* **2014**, 21(5), 1893–1899.
28. Junk, W.R.; Pancoast, H.M. Boiling point elevations of sugar solution. In: Pancoast, H.M. (Ed.), Handbook of sugars: For processors, chemists & Connecticut, **1973**, 42–66.
29. Khan, M.M.; Islam, M.T.; Chowdhury, M.M.H.; Alim, S.R. Assessment of microbiological quality of some drinks sold in the streets of Dhaka university campus in Bangladesh. *International Journal of Food Contamination,* **2015**, 2(4), 1–5.
30. Li, Q.; Yan Yue, O.; Jian Sun, H.; Su, Y.; Yu Gao, B. A comparative study on the properties, mechanisms and process design for the adsorption of nin–ionic or organic dyes onto cationic–polymer/bentonite. *Journal of Environmental Management,* **2010**, 91, 1601–1611.
31. Lin, C.I.; Joseph, A.K.; Chang, C.K.; Wang, Y.C.; Lee, Y.D. Estimation of caffeine in tea samples by spectrophotometrically. *Analytica Chimica Acta,* **2003**, 481, 175–180.
32. Makhlouf–Gafsi, I.; Baklouti, S.; Mokni, A.; Danthine, S.; Attia, H.; Blecker, C.;

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Besbes, S.; Masmoudi, M. Effect of ultrafiltration process on physicochemical, rheological, microstructure and thermal properties of syrups from male and female date palm saps. *Food Chemistry,* **2016**, 203, 175–182.
33. Metin, M. Analysis Methods of Milk and Dairy products (Sensory, Physical and Chemical Analysis). Ege University Publications, Bornova, **2006**.
34. Prescott, L.M.; Harly, J.P.; Kleen, D.A. Food Microbiolgy, 5th ed. McGraw Hill Book Co., New York, **2002**, 352–627.
35. Rashed, K.; Butnariu, M. Isolation and antimicrobial and antioxidant evaluation of bio-active compounds from *Eriobotrya japonica* stems. *Advanced pharmaceutical bulletin*, **2014**, 4(1), 75–81.
36. Rikka, J.; Vertti, V.; Outi, P.; Arja, L. Microbiological spoilage and safety risks in non–beer beverages produced in a brewery environment. Espoo, VTT Tiedotteita–Research, Notes, **2011**, 2599, 107.
37. Samfira, I.; Rodino, S.; Petrache, P.; Cristina, R.T.; Butu, M.; Butnariu, M. Characterization and identity confirmation of essential oils by mid infrared absorption spectrophotometry. *Digest journal of nanomaterials and biostructures*, **2015**, 10(2), 557–566.
38. Sawaya, W.N.; Khalil, J.K.; Safi, W.N.; Al–Shalhat, A. Physical and chemical characterization of three Saudi date cultivars at various stages of development. Canadian Institute of *Food Science and Technology Journal,* **1983**, 16, 87–92.
39. Shen, D.; Fan, J.; Zhou, W.; Gao, B.; Yue, Q.; Kang, Q. Adsorption kinetics and isotherm of anionic dyes onto organo–bentonites from single and multisolute systems. *Journal of Hazardous Materials,* **2009**, 172, 99–107.
40. Tribst, A.A.; Sant'Ana, S.; de Massaguer, P.R. Microbiological quality and safety of fruit juices–past, present and future perspectives. *Critical Reviews in Microbiology,* **2009**, 35(4), 310–339.

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