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Evaluation of the quality of the date syrups enriched by cheese whey during the period of storage

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Abstract. This study was carried out to the valuing of the date variety *H'mira* (very rich's in sugars and in nourishing elements) and the cheese whey for production of novel syrups. Four samples syrups were manufactured: control represent date syrup obtained after hot extraction at a concentration 20 %, syrups (A) represent control with 10 % of cheese whey, syrup (B) with 20 % and syrup (C) with 30 % of cheese whey. These syrups were stored during 3 weeks at 4 °C. The biochemical, microbiological and sensory evaluations for all syrups were evaluated every week of storage. The biochemical characterization of syrups showed that it's richness in total sugars, proteins contents, ash and dry mater. The syrup of date enriched with 10 % of liquid acid cheese whey present a good biochemical quality (higher level of sugars, proteins and ash) and important sensorial properties (color, odor and flavor). This syrup can be used for beverage or as medium to fermentation for production a new products.
***Keyword**:* Date, Syrup, *H'mira*, Cheese whey, Quality, Storage.

Introduction

The date palm (*Phoenix dactylifera* L.) belonging to the Arecaceae family represents an important economical culture for countries of the Middle East and North Africa [AL–KHALIFAH *et al.,* 2013; CHANDRASEKARAN and BAHKALI, 2013]. Algeria is a date producer country with an annual production of more than 500 000 t, the number of date palms is estimated at more than ten million [MESSAR, 1996; HANACHI *et al.,* 1998]. Date palm cultivars are divided to three main types according to their fruit moisture content as soft, semi–dry and dry cultivars [ELHOUMAIZI *et al.,* 2002].

Dates contain a high percentage of sugars reaching 88% in some varieties [AL–SHAHIB and MARSHALL, 1993] and mineral salts [AL–HOOTI *et al.,* 1997] but poor in fat and virtually free from cholesterol and sodium.

The Deglet Nour variety is in first place 46.23 % followed by Deglet Beidha 32.9 % [BOUGHNOU, 1988]. The dates destined to the local consumption and to the export has good quality. However, other varieties (30 % of the national production), known as common are less quality.

Theses varieties are very rich in nutriments elements: carbohydrates, vitamins, ash, and minerals salts. Today's dairy process has ability to convert raw milk to different new products, in order to improve efficiencies of traditional products and to introduce new products for expanding the dairy product market [HENNING *et al.,* 2005].

Cheese production in Algeria has more than higher during the last years; such increase generated large amounts of whey. Cheese whey, the yellow–green liquid remaining after the precipitation and removal of milk casein during cheese making process through the action of chymosin or mineral/organic acid, which contains most of the water-soluble components and water present in milk [GHALY and KAMAL, 2004; FERCHICHI *et al.,* 2005; SMITHERS, 2008]. The chemical composition of whey differs according to the quality and the composition of milk, types of cheese produced, cheese production techniques used, amount of yeast, acid used for coagulation, period and temperature of coagulation [KAVACIK and TOPALOGLU, 2010].

CW represents 85 %–95 % of the milk volume and retains about 55 % of the milk nutrients [FARIZOGLU *et al.,* 2004]. It is composed of 92–95 % w/w water and 5–8 % w/w dry matter, the most abundant of these nutrients are lactose 45–50 g/L, soluble proteins 6–8 g/L, lipids 4–5 g/L and mineral salts 8 %–10 % of the dry extract [BENSALEM and FRAJ, 2007].

According to the production process and the coagulation of casein, the CW is divided into two categories: acidic whey, which has a pH of less than 5, and sweet whey with a pH value between 6 and 7 [BYLUND, 1995].

Cheese Whey is the raw material from which many products are manufactured. They can be used as high-quality food and feed ingredients and utilized in feeding large ruminants to produce milk [STOCK *et al.,* 1986; CASPER and SCHINGOETHE, 1986].

The lactose content of cheese whey and the presence of other essential nutrients for microbial growth make this dairy by–product a potential feedstock for the production of valuable compounds through fermentation processes [PANESAR *et al.,* 2007].

Fruits of date palm are consumed throughout the world and are a vital component of the diet in most Arabian countries. Consumers are increasingly searching for innovations of the food industry whenever they are able to make their own food choices. In the context of a double valuation of the date variety *H'mira* and cheese liquid acid whey, the aim of our work is to study the biochemical, microbiological and sensorial quality of syrup obtained from the juice of dates and liquid whey and its stability during three weeks of storage.

Material and methods

The cheese whey was obtained from Giplait of Sidi Bel Abbes (Algeria) in the month of June 2014 and the date was a variety half soft, known as *H'mira* badly exploited, collected in the month of June 2014 from the area of Bechar (south–west of Algeria). For extraction of date syrups, vegetable materials were chopped into small particles (1–3 cm) to increase the surface of diffusion. The extraction parameters were obtained from method advocated by Turhan [TURHAN *et al.,* 2008].

Figure 1. Date variety *H'mira*, cheese whey and all syrups manufactured.

One liter of hot water at 80–85 °C was added to 200 g of date during 2 h, homogenized and filtered through a cloth. The syrup obtained was centrifuged at 15.000 rpm for 10 min to separate the cellulose debris.

The syrup control represents the date syrups without addition of the cheese whey, syrup (A) was obtained by mixing of date syrups with 10 % of the cheese whey, syrup (B) with 20 % of the cheese whey and syrup (C) with 30 % of the cheese whey.

The all syrups were fixed in a pH 4 by addition of the citric acid 0.5 N and sterilized during 20 min at 80 °C.

All samples were conditioning in the bottles and storage at 4°C (Figure 1). The syrups were then homogenized to obtain a uniform mixture for further analysis (biochemical, microbiological and sensory properties) at different storage intervals (1, 7, 15 and 21 days).

Biochemical analysis

Samples were analyzed chemically according to the officinal methods of analysis described by the Association of Officinal Analytical Chemist [AOAC, 2007].

The density was measured by density meter and the moisture content by measuring the mass of the sample before and after water is removed by evaporation

at 105 °C for 24 h (until constant mass was achieved). The pH was measured by using a digital pH meter and titrable acidity was determined by manual titration of suitable quantity (10 mL) with standardized 0.1N NaOH using phenolphthalein as indicator. The volume of NaOH required to neutralize the date was recorded and used to calculate the content of titrable acids.

For determination of the optical density, 50 mL of diluted sample were centrifuged at 2300 rpm for 20 min, 25 mL of the supernatant were mixed with 25 mL of 95 % ethanol and then filtered.

The optical density was measured by spectrophotometer at 420 nm [GARZA *et al.,* 1999]. The total proteins content of the different samples was determined using the nitrogen content, based on the Kjeldahl method digestion and distillation apparatus [AOAC, 2007; HAMON *et al.,* 1990].

All protein contents were expressed as percentage. Total sugars were determined colorimetrically at 480 nm by Dubois method [DUBOIS *et al.,* 1956].

The ash content was determined according to the AOAC official method 972.15 by incineration 5 mL of date syrups at 600 °C for 3h [AOAC, 2006].

Microbiological analysis

The microbiological quality was determined by enumeration of total plate count (TPC) in the TGEA (Triptone Extract Glucose Agar) after incubation for 72 h at 30 °C [FDA, 2002].

All colonies were counted on those plates containing 30 to 300 colonies and multiplied by dilution factor. Arithmetic average was counted as total plate count per mL [ANON, 2000].

Faecal streptococci were counted in Roche presumptive medium contain sodium azohydrate and Litsky confirmation medium contains sodium azohydrate and purple ethyl. Search sulfite–reducing *Clostridium* can be done by counting the sporulated forms which develop in media VF containing sodium sulphite and iron alum after 48 h at 37 °C [GUIRAUD, 2003, BUTU, *et al.,* 2014c, BUTNARIU, *et al.,* 2015].

The total and fecal coliforms were counted, respectively desoxycholate lactose agar and violet red bile lactose agar (VRBL) after 24 to 48 h at 37 °C for total coliforms and at 44 °C for faecal coliforms [FDA, 2002].

Staphylococcus aureus on Giolitti Cantonii and Chapman agar after 24 to 48 h at 37 °C [FDA, 2002].

Enumeration of molds and yeasts was carried out in the samples using the medium of acidified potato dextrose agar (Mu96, Himedia, Mumbai) supplemented with oxytetracycline after 5 days at 25 °C.

The method recommended by FDA [FDA, 2002] was followed up.

All colonies were counted on the plates containing less than 50 colonies and multiplied by dilution factor.

Arithmetic average was counted as total plate count per mL.

Sensory evaluation

All the samples were evaluated for sensory characteristics: flavor, color, odor and acidity by 20 panelists (students and technicians from University of Mascara, Algeria); using a point scale: 7: good, 5: acceptable, 3: poor, 1: bad [METIN, 2006].

Results and discussion

Biochemical and microbiological composition

According to our results of pH and acidity presented in table 1, it is found that the date and cheese whey (raw materials) used have an acidic character which can improve the freshness and taste of the syrups. A pH stability of around 4 is observed for all syrups and throughout the storage period. This value is agreement with the results obtained by Rygg [RYGG 1975] and who advocate acidity in the range of 2.2 to 6.3 g acid/kg and with the work of Belguidj and Abekhti and collab. [BELGUIDJ, 1996, ABEKHTI *et al.,* 2013].

A slight increase in acidity from 4 to 5 due to the increased dose of the added liquid acid cheese whey, but this acidity decreases slightly during storage period.

Optical density is a parameter that judges the polymerization reactions and browning that generated products may give a darker color to the product and evaluates the nutritional quality. It is essential for food process to minimize the colour losses during processing and storage [AHMED and RAMASWAMY, 2006].

The optical density of date is 0.47±0.01 compared with liquid acid cheese whey 0.21 ± 0.02. Optical density decreases with the addition of the cheese whey. The date *H'mira* is a semi–dry variety characterized by 85 ± 0.3 % of dry matter whereas the whey has a 10.42±0.3 % of dry matter. This level of date dry matter corresponds to the standard 81 to 85.5 [BELGUEDJ, 1996].

Table 1.

Biochemical and microbiological analysis (A. Date with 10 % of cheese whey, B. Date with 20 % of cheese whey, C. Date with 30 % of cheese whey. Vales represent Mean ±sd; n=3).

Samples / Parameters	Day of Storage	Date	Cheese Whey	ontrol	A	B	C
pH	1	5.03±0.01	4.1 ±0.02	4±0.01	4±0.01	4±0.01	4±0.0
	7			4.09±0.01	4.05±0.01	4.04±0.02	4.0 ±0.01
	14			4.01±0.01	4.01±0.02	4.02±0.02	4.04±0.02
	21			3.97±0.02	3.98±0.01	3.97±0.03	3.99±0.03
Titrable acidity g/Kg	1	3±0.3	12±0.3	4±0.2	4±0.1	5±0.3	5±0.3
	7			3.5±0.1	3±0.2	3.5±0.2	3±0.1
	14			3±0.3	3±0.3	3.5±0.2	3±0.2
	21			2.5±0.2	2.5±0.1	3±0.3	3±0.3
Dry mater %	1	85±0.3	10.42±0.3	15.2±0.4	15.2±0.3	13.04±0.3	13.01±0.1
	7			4.31±0.3	14.31±0.2	12.38±0.2	12.6±0.4
	14			14±0.1	10±0.4	10±0.2	10±0.5
	21			13±0.1	9±0.3	8±0.3	8±0.2
Ash %	1	1.82±0.02	2.50±0.03	0.35±0.03	0.75±0.02	1.18±0.01	1.38±0.01
	7			0.33±0.02	0.69±0.02	1.13±0.01	1.38±0.03
	14			0.31±0.05	0.62±0.05	1.18±0.04	1.4 ±0.03
	21			0.32±0.0	0.65±0.03	1.17±0.03	1.44±0.04
Density g/mL	1	–	0.93±0.04	0.9±0.02	0.97±0.01	0.97±0.03	0.98±0.03
	7			0.88±0.04	0.94±0.02	0.91±0.05	0.88±0.01
	14			0.9±0.03	0.9±0.04	0.92±0.05	0.9±0.04
	21			0.85±0.01	0.8±0.01	0.9±0.03	0.84±0.02
OD at 420 nm	1	0.47±0.01	0.21±0.02	0.1 ±0.02	0.09±0.03	0.04±0.02	0.03±0.01
	7			0.16±0.03	0.16±0.01	0.1±0.03	0.09±0.01
	14			0.12±0.01	0.1±0.02	0.2±0.02	0.12±0.01
	21			0.11±0.03	0.09±0.02	0.1±0.01	0.11±0.02
Total sugars %	1	70±0.3	20±0.3	32±0.4	43±0.5	48±0.4	64±0.3
	7			30±0.1	38±0.4	35±0.2	40±0.3
	14			39±0.2	20±0.1	43±0.4	50±0.3
	21			25±0.3	20±0.3	30±0.2	40±0.1
Proteins %	1	3.42±0.04	15.4±0.01	6.7 ±0.02	6.8±0.01	8.55±0.04	10.3±0.03
	7			5.13±0.01	6.84±0.04	6.84±0.04	8.55±0.01
	14			4.69±0.02	6.55±0.03	6.69±0.04	7.69±0.04
	21			4.39±0.02	6.47± 0.01	6.5±0.03	6.5±0.03
Total Plate Count UFC/g (*10^2)	1	4	/	12.7	11.4	16.3	9.5
	7			8.9	11.8	17.2	18.4
	14			7	5.6	6.9	17.3
	21			5	3.5	5.6	10
Yeasts and moulds UFC/g (*10^2)	1	3	/	12	11	16	9.5
	7			8.7	11.6	17	18
	14			6.5	5.4	5	17
	21			4	1	4	5

The addition of the liquid acid cheese whey to the date causes a dilution effect and a reduction in the dry matter of the syrups as a function of the added quantity.

The high moisture content facilitates spoilage of dates and low moisture content lead to dry dates not acceptable to consumers.

Ours results are agreement from the observation of Barreveld who reported that moisture content in date fruits at different stages of development were about 50–60 % for sweet khalal, fleshes

varied between 9.73 and 17.52 g/100 g, being lowest in Um–sellah and highest in Shahal [BARREVELD, 1993, BUTU, *et al.,* 2014a, BUTNARIU, 2012]. Dates are a good source of certain minerals (potassium and calcium), this explains considerable ash content in dates. The ash content in the date is 1.82 ± 0.02 %, less than that shown in liquid cheese acid whey 2.5±0.02 %. The level of ash in liquid acid cheese whey reported by Bensalem and Fraj is 8 % [BENSALEM and FRAJ, 2007]. The addition of the cheese whey to the date causes an increase in the mineral content of these syrups and in the density. Sugars are the most abundant base constituents and the most important in the date and consequently, their percentage in dates is very high compared to other constituents. The total sugar content is measured at 70 ± 0.3 %, a very significant amount for which the date is considered a high–energy food.

Total sugars content of the whey is order to the 20 ± 0.3 %, a very large amount for a non–upgraded product, improves the nutritional value of the syrups. The carbohydrate content of date is agreement with results 65 % obtained by Omowunmi and Ayoade [OMOWUNMI and AYOADE, 2013]. According to the results clearly presented in table 1, the cheese whey protein level is 15.4 ± 0.01 %.

This value is higher than indicated by Bourgeois and Leroux which varies between 11 to 13 % [BOURGEOIS and LEROUX, 1991, PETRACHE, *et al.,* 2014, BUTU, *et al.,* 2014b].

According to Matalah, the protein content is 2 %, our results indicate a rate of 3.42 ± 0.04 %. This shift in the result is due to the difference in composition of varieties. The addition of cheese whey to dates syrups improves and increases the protein content and amount of sugars [MATALAH, 1970, RODINO, *et al.,* 2014, BUTU, *et al.,* 2015].

Table 2.

Sensory evaluation of date syrups.

	Sate Syrups	Good	Acceptable	Poor	Bad
Color	Control (date syrup)	65	25	5	5
	A (DS, 10% of whey)	45	35	15	5
	B (DS, 20% of whey)	20	35	30	15
	C (DS, 30% of whey)	10	25	35	30
Flavor	Control (date syrup)	45	25	20	10
	A (DS, 10% of whey)	65	25	10	/
	B (DS, 20% of whey)	30	20	35	15
	C (DS, 30% of whey)	20	20	40	20
Odor	Control (date syrup)	70	15	10	5
	A (DS, 10% of whey)	55	25	10	10
	B (DS, 20% of whey)	30	15	35	20
	C (DS, 30% of whey)	15	10	40	35
Acidity	Control (date syrup)	20	55	20	5
	A (DS, 10% of whey)	30	35	35	/
	B (DS, 20% of whey)	50	25	20	5
	C (DS, 30% of whey)	60	15	15	10

According to our results (table 1), the total plat count (TPC) is very high and this is logical because the date *H'mira* are used properly packed and marketed under the same conditions that are unhygienic and that because bacterial contamination. The change in TPC for date is in conformity with the findings of Al–Hooti and collab. [AL–HOOTI *et al.,* 1997].

The total Plat Count TPC decreases during storage time for all syrups analyzed. The presence of yeasts and moulds causes an alteration, modification of the nutritional value and the occurrence of undesirable flavor [BOURGEOIS and LEVEAU, 1991]. The number of yeast and moulds is high in the date syrups during storage.

Note the total absence of faecal streptococci, sulphite–reducing Clostridium, *Staphylococcus aureus* and total and fecal coliforms.

It can be reported the presence of tannins that limit the presence of certain bacteria in dates syrups.

Sensory evaluation

Table 2 show the results obtained for the sensory analysis carried out of the assay. Date fruits may be considered as an almost ideal food providing a wide range of essential nutrients and potential health benefits [EL–SOHAIMY and HAFEZ, 2010].

The date syrup enriched with 10% of cheese whey (A) had significantly higher color, flavor and odor score followed by date syrup control with higher score of color and odor.

The date syrups B and C enriched by 20 and 30 % of cheese whey have a higher score of acidity. This acidity can be attributing to the acidity of cheese whey used.

Conclusions

Date fruit is very rich in sugars and has a high nutritional value which makes it suitable for being used as an ingredient in confectioneries. In recent years an important part of food research has been primarily focused on new formulation products.

Today's dairy process has ability to convert raw milk to different new products, in order to improve efficiencies of traditional products and to introduce new products for expanding the dairy product market. Cheese whey is one of these bio products generated.

Consumers are increasingly searching for innovations of the food industry whenever they are able to make their own food choices. In the context of a double valuation of the date variety *H'mira* and cheese liquid acid whey, the aim of our work was to study the biochemical, microbiological and sensorial quality of syrups obtained from the juice of dates enriched with liquid whey and its stability during three weeks of storage.

Based on present results, it can be concluded that the syrups of date enriched with 10 % of liquid acid cheese whey present a good biochemical quality (higher level of sugars, proteins, vitamins and ash) and important sensorial properties (color, odor and flavor).

This syrup can be used as beverage or medium to fermentation for production some new products.

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