



Technological characteristics of fermented milk product manufactured by milk-dates mixtures

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ABSTRACT

The objective of this study was the elaboration and characterization of milk-dates mixtures and utilization of this new food system for the production of steamed yoghurt. Dates at 9, 20 and 30% were mixed with milk at 30 °C and 45 °C for 2.5 hours. The addition of dates to milk increased the levels of density, viscosity, dry matter, proteins, pectin, ash and mineral salts. A certain stability of the quantity of lactose and a slight decrease in total fat were observed. The percentage of sugars increased gradually and stabilized at a value of 6% compared with the control 4.5%. All samples of milk were of satisfactory hygienic quality. Milk-dates mixtures were appreciated by panelists for their best color taste and flavor. The mixture prepared at 30 °C remained stable after 19 hours while the mixture at 45 °C became a coagulum after 7 hours. The emulsifying power increased gradually with the concentration of the dates used and the foaming power of the control milk was the highest compared with the mixtures, i.e. it was 26.8% at the beginning, and then decreased to 16.6% after 45 min. Yoghurts prepared with milk-dates mixtures were marked by good biochemical, microbiological and sensory characteristics. The study found that the new milk-dates system is very rich in nutritional elements and able to produce steamed yoghurts of good quality and high acceptability to consumers.

Keywords: date, milk, mixture, quality, yoghurt.

ИЗВОД

Циљ овог рада је био разрада и карактеризација смеша млеко-урме и употреба овог новог система за производњу јогурта на пари. 9, 20 и 30 % урми су мешани са млеком на 30 °C и 45 °C током 2,5 сата. Додавање урми млеку повећало је ниво густине, вискозности, суве материје, протеина, пектина, пепела и минералних соли. Примећена је одређена стабилност количине лактозе и благи пад укупне масти. Процент шећера се постепено повећавао и стабилизовао на вредности од 6% у поређењу са контролном 4,5%. Сви узорци млека су били задовољавајућег хигијенског квалитета. Мешавину млеко-урме су анкетирани потрошачи најбоље оценили због њеног најбољег изгледа и укуса. Смеша припремљена на 30 °C остала је стабилна после 19 сати, док је смеша на 45 °C постала коагулум после 7 сати. Моћ емулговања постепено се повећавала са концентрацијом употребљених урми, а пенушавост контролног млека била је највећа у поређењу са смешама, тј. На почетку је износила 26,8%, а затим се смањила на 16,6% након 45 минута. Јогурти припремљени са млечним мешавинама обележени су добрим биохемијским, микробиолошким и сензорним карактеристикама. Студија је открила да је нови систем млечних-урме веома богат нутритивним елементима и способан је да произведе парирани јогурте доброг квалитета и високе прихватљивости за потрошаче.

Кључне речи: урме, млеко, мешавине, квалитет, јогурт.

1. Introduction

The fruit of the date palm (*Phoenix dactylifera* L.) is one of the most abundant fruits in the world. The date palm belonging to the Arecaceae family is an important crop for many countries (Al-Khalifah *et al.*, 2013). It has been cultivated across the Middle East and North Africa for over 5000 years (Chandrasekaran and Bahkali, 2013). The date fruit contains a wide range of nutritional functional substances. It is rich in digestible sugars like glucose, fructose and sucrose (70%), dietary fibers, proteins, pectin, lipids, mineral salts, and vitamins (Al-Farsi *et al.*, 2006). Most of the carbohydrates in this product are in the form of glucose and fructose, which are

easily absorbed by the human body. The varietal structure of Algerian palm dates provides varieties of high quality and excellent commercial value destined for export and local consumption (*Deglet-Nour*). Other varieties known as common dates (*Hmira*, *H'loua*) are of low market value, less appreciated, and of negligible commercial interest and limited economic importance (Ahmadnia and Sahari, 2008). The large quantities of the produced dates do not meet the minimum quality attributes for direct use. Therefore, low and medium quality dates that are not directly consumed by humans have been used as raw materials of the fermentation industry or animal feed for many years and are considered low-price. The non-use of this by-product for human food constitutes

a real economic loss. Recently, innovative date by-products have been developed aiming at producing value added products of higher nutritional value. However, the production of sweeteners of high nutritional quality from date by-products for granular sucrose substitution in food formulations is a prime target. Dates at different forms (date syrup, date concentrate, date powder, and date liquid sugar) are ideal substitutes for added sugar in foods due to their economic value and richness in sugars and bioactive molecules. The scientific evidence states that higher consumption of added sugar (refined white sugar) increases the risk of overweight and obesity and also other risk factors for cardiovascular diseases (Johnson and Yon, 2010). Dates have been used in several food preparations in order to replace added sugar. Dates were 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). However, the qualities, especially texture and color of reformulated products, were affected. All these date by-products are in a liquid state having different physical properties compared with sucrose and their application in food production faces major difficulties. These are due to the highly viscous liquid like state of date by-products causing operational and technological challenges for their packaging, transport, handling, piping and mixing with other ingredients. Moreover, the inclusion of highly viscous date by-products into yoghurt is likely to change the activity of the starter culture and final product quality. Until now, milk-date mixtures have not been used in food formulations. This by-product, due to its homogeneity, can be used as an ingredient of choice for many food formulations such as yoghurt, and can enhance the quality of reformulated products compared with the utilization of other date derivatives. This study aimed to investigate the elaboration and characterization of the milk-dates mixture and its ability to produce fermented milk (yoghurt).

2. Material and Methods

Chemical substances

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

Plant material and optimization of milk-dates mixture

The fruits of the common date variety *H'loua* at the tamar stage of maturity were harvested in September 2017 from the region of Adrar (South of Algeria). The choice of this variety was based on its availability, low cost and its important nutritive value, especially the content of reducing sugars. For the preparation of milk-dates mixtures, date fruits were washed, pitted, cut into small particles and crushed. Preliminary tests were performed to optimize the diffusion of the date components to the milk. Various parameters governing this diffusion were optimized (diffusion duration, temperature and filtration). The OFAT (one factor at a time) method was used to optimize these parameters. This diffusion can be verified by the evaluation of the amounts of dry matter and total sugar. In order to optimize the duration of diffusion, the milk-dates

mixture was prepared at 30 °C at a percentage of 20% and the dry matter and sugar contents were determined at different times. The duration of diffusion was 2.5 hours. To optimize temperature, the percentage of dates used was fixed at 20% for 2.5 hours and the temperature was varied between 30 and 45 °C, the temperature chosen was 45 °C. To verify the effect of filtration, milk-dates mixtures were prepared at different percentages for 2.5 hours at 45 °C and the amounts of sugar and dry matter before and after filtration were determined. Finally, date powder was mixed with milk at various percentages (9, 20 and 30%), homogenized with an Ultra-Turrax T25 mixer (IKA-Werke GmbH, Germany) at 30 °C and 45 °C for 2.5 hours and then filtered. Physico-biochemical, rheological, microbiological and sensory characteristics of the milk-dates mixtures were determined.

Physico-biochemical characterization

The proximate composition of the samples was analyzed chemically according to the official methods of analysis described by the Association of Official Analytical Chemists (AOAC 2007). The viscosity was measured by using a drop bile viscometer (HAAKE) and the density was evaluated at 25 °C by weighing the sample contained in a 25 mL pycnometer using a four-digit Sartorius-GE412 balance, Germany (Jagannadha-Rao *et al.*, 2009). The pH was measured using a digital pH meter (Mettler Toledo. MP220) and titratable acidity (TA) was evaluated by manual titration of 10 mL with standardized 0.1 N NaOH using phenolphthalein as indicator. The volume of NaOH required to neutralize the sample was recorded and used to calculate the content of titratable acids. The dry matter level was calculated after evaporation of the water present in the sample placed in an oven 105 °C for 24 hours (SPAG, Massy, France) until constant mass was obtained. Total sugar was evaluated colorimetrically at 480 nm by the Dubois method (Dubois *et al.*, 1956). Standards were prepared with glucose solutions at different concentrations. For quantification of the pectin content, 10 g 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, and 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 (Nabertherm, Germany) at 700 °C; we noted a further weight P2 (AOAC, 2007). The percentage of pectin was calculated by the following formula: $\text{Pectin \%} = (P_1 - P_2 / M) * 100$. Total nitrogen and protein content were evaluated by the Kjeldahl method (AOAC, 2007). The protein content was determined using a factor of 6.25. The formaldehyde titration assay was used to determine the total protein content of dairy products (Ceirwyn, 1999). The lactose and total fat contents were evaluated by the Bertrand and Gerber methods, respectively (Wehr and Frank, 2004; O'Connor, 1995). The ash content was determined according to the AOAC official method 972.15 by incineration of 5 grams of sample in a muffle furnace (Nabertherm, Germany) at 600 °C for 3 hours (AOAC, 2007). The levels of mineral elements were determined using an atomic absorption emission spectrophotometer according to the method advocated by Hamon *et al.* (1990).

Rheological analysis

For evaluation of the stability and ability to coagulate, milk-dates mixtures were prepared at 30 °C and 45 °C and titratable acidity (TA) was evaluated at different time intervals. The time required for the mixture to begin to coagulate was noted as well. To evaluate the emulsifying power (Ahmedna *et al.*, 1999), 1 mL of the sample was added to 10 mL of the lipid and centrifuged at 3000 rpm for 20 minutes (Sigma laborzentrifugen D-37620 Osterode am Harz, Germany). The lipid retention capacity was calculated from the following formula:

$$\text{Lipid retention capacity} = \frac{P1 - P2}{P2} * 100$$

P1: Weight of the pellet in gram, P2: Weight of the test sample. The activity and stability of the foam were determined by the method described by Lin *et al.* (1974). An aliquot of 10 mL of the sample was homogenized with an Ultra-Turrax T25 mixer (IKA-Werke GmbH, Germany) and immediately transferred into a 50 mL graduated cylinder. After stirring for 5 minutes, foam volume was measured. Foaming capacity was expressed as a percentage increase in volume. Foam stability was expressed as foam volume remaining after 15, 30 and 45 minutes.

Microbiological evaluation

The microbiological quality of the samples was evaluated by enumeration of total plate count TPC in the TGEA (Trioportone Extract Glucose Agar) after incubation at 30 °C for 72 hours. All colonies were counted on those plates containing 30 to 300 colonies and multiplied by the dilution factor. Arithmetic average was counted as total plate count per gram (Anon 2000). Total coliforms were counted in desoxycholate lactose agar for 24 to 48 hours at 37 °C (Tribst *et al.* 2009). Mean *Salmonella* count was obtained in *Salmonella* agar and the plates were incubated for 24 to 48 hours at 37 °C, after enrichment in Selenite-F Broth (SFB) medium for 24 to 48 hours at 37 °C. *Staphylococcus aureus* counts were determined on Giolitti Cantoni and Chapman agar after 24–48 hours at 37 °C. The yeasts and molds were counted on Potato Dextrose Agar supplemented with oxytetracycline after incubation for 5 days at 25 °C. All colonies were counted on the plates containing less than 50 colonies and multiplied by the dilution factor.

Sensory evaluation (Metin, 2006)

All samples were evaluated for sensory characteristics (taste, color, texture and flavor) by 20 panelists (students and technicians from University of Mascara); using a point scale (5: good, 3: acceptable, 1: bad). Each sample was evaluated using Quantitative Descriptive Profile Analysis (QDA) according to El-Dash (1978).

Potential use of milk-dates mixture for preparation of steamed yoghurt

A commercial frozen yoghurt starter culture containing *Lactobacillus delbrueckii* subsp. *bulgaricus* and *Streptococcus thermophilus* obtained from the GIPLait unit of Tizi (Mascara, in West of Algeria) was reactivated by inoculation in sterilized milk. One liter of partially skimmed milk was sterilized at 100 °C for 5 minutes and then the temperature was decreased to 45 °C. The starter culture was then mixed at a 1:1 ratio and incubation was carried out at 45 °C until maturation (titratable acidity of 75 to 80 °D). The fermentation was stopped by cooling to 4 °C. For the manufacture of the control yoghurt (CY), 54 g of milk powder at 0% of fat content and 80 grams of crystallized sucrose were added to one liter of partially skimmed pasteurized milk. The mix was heated to 95 °C for 2 min, homogenized and then rapidly cooled to 45 °C. The starter culture was added to the mix at 2% and then agitated. Incubation was carried out at 45 °C for 2 to 3 hours (until the acidity of 70 to 80 °D) and stopped by cooling to 4 °C. Four steamed yoghurts were manufactured: Control (CY), MY9 (utilization of milk-dates mixture at 9%), MY20 (20%) and MY30 (30%). All yoghurts were stocked at 4 °C and then analyzed after 1, 7, 15 and 21 days of storage for proximate composition (pH at 25 °C, titratable acidity TA, dry matter, total proteins, total sugar, fat and ash content). Sensory characteristics were evaluated to determine the acceptability of the yoghurts after 21 days of storage.

Statistical analysis

All analyses were done in triplicate. The data were statistically evaluated by analysis of variance ANOVA at the level of significance $p \leq 0.05$ using Microsoft Excel 2010 and SPSS Statistics software 8.1.

3. Results and discussion

Optimization of milk-dates mixture parameters

This preliminary test was conducted to optimize the diffusion of date components to the milk. For optimization of diffusion time, the results showed that the percentage of dry matter changed with increasing diffusion time from 10.6 ± 0.3 to $12.8 \pm 0.3\%$ after 1 hour, to 16.5 ± 0.1 after 2.5 hours and to $19 \pm 0.1\%$ after 3 hours of action. Total sugar evolved from 3 ± 0.1 to $4.3 \pm 0.1\%$ after 1 hour, and then stabilized at a value of $4.5 \pm 0.2\%$ after 2.5 and 3 hours. We opted for a milk-date mixing duration of 2.5 hours. For optimization of the temperature, the percentage of dry matter increased from $11 \pm 0.2\%$ to $14.2 \pm 0.3\%$ at 30 °C and from $11 \pm 0.2\%$ to $19 \pm 0.1\%$ at 45 °C. The temperature chosen was 45 °C. Results showed that in filtered mixtures, the amount of dry matter was 18.4 ± 0.2 , 26.8 ± 0.1 and $28.4 \pm 0.1\%$ for mixtures at 9, 20 and 30%, respectively, compared with unfiltered mixtures 14 ± 0.3 , 16.4 ± 0.3 and 20.8 ± 0.2 . For total sugar, in filtered mixtures, the level of sugar was 4.4 ± 0.03 , 4.4 ± 0.02 and 4.6 ± 0.02 at 9, 20 and 30%, respectively, compared with unfiltered mixtures: 4.5 ± 0.01 , 4.5 ± 0.02 and $4.5 \pm 0.03\%$. Filtration considerably reduced the percentage of dry matter. After filtration, the color of the mixture became darker depending on the concentration used compared with the unfiltered mixture. It seems that the filtration operation removes

the fibers that have the ability to absorb pigments and sugar.

Proximate composition

The pH values of the date flesh and powder dates were 5.9 ± 0.03 and 5.5 ± 0.02 , respectively. The obtained results concord with the work of Abekhti et al. (2013). During preparation of the mixtures, certain organic acids diffused and gave a slightly acidic character to the milk, which explains the decrease in the pH from 6.94 ± 0.04 to 6.79 ± 0.04 and the increase in the TA from 16 ± 0.3 to 24 ± 0.3 °D (Table 1). This variation of TA was lower and it had no effect on the final quality and acceptability of the milk-dates mixture to consumers. The density and viscosity of the milk-dates mixture increased gradually with the percentage of the dates used. The increase in these parameters was due to the contribution of soluble matter to the composition of the aqueous phase and of insoluble fibers to the increase in total solids, and affected the three dimensional conformation of the hydrated biopolymers. Our results are in agreement with the findings of Salem et al. (2017). Smith et al. (1984)

reported that an increase of the changes in arrangement of water molecules around the sugar molecules were able to bring about changes in water absorption and increase the viscosity. The moisture content of the date flesh was 13.4%, and the dry matter content 86.6%. This value is in agreement with the results 10.57% obtained by Abekhti et al. (2013). Date powders had a total dry matter content of 95.96%; this value is not consistent with the result 89% obtained by El-Sharnouby et al. (2012). The addition of dates to the milk increased the total dry matter of all milk-dates preparations. The migration of date substances to the milk explains the considerable increase in the level of dry matter from $12.6 \pm 0.2\%$ for milk to $22.8 \pm 0.2\%$ for mixture at 30% of dates. The carbohydrate contents of date flesh and date powder (84.1 ± 0.3 and 85.7 ± 0.1 , respectively) are higher than the results 65% cited by Benahmed et al. (2013). Carbohydrates, including soluble sugar and dietary fiber, are the predominant components of date palm (44–88%), followed by moisture, with only a small amount of fat (0.2–0.5%), proteins (2.3–5.6%), dietary fiber (6.4–11.5) and ash (Al-Shahib and Marshall, 2003).

Table 1
Proximate composition of dates, date powder and milk-dates mixtures.

Parameters	Dates		Milk-dates mixtures			
	Flesh	Powder	Control	9%	20%	30%
pH at 25 °C	5.9±0.03	5.5±0.02	6.94±0.04	6.91±0.03	6.89±0.04	6.79±0.04
TA °D	2.38±0.2	4.2±0.1	16±0.3	18±0.2	24±0.3	24±0.3
Density Kg/m ³	/	/	1028±1	1058±2	1066±2	1078±3
Viscosity Pas. s	/	/	1.5±0.01	1.6±0.01	1.7±0.01	2±0.01
Dry matter (%)	86.6±0.2	95.96±0.3	12.6±0.2	16±0.3	18.4±0.2	22.8±0.2
Total sugar %	84.1±0.3	85.7±0.1	4.5±0.02	6±0.02	6±0.01	6±0.03
Proteins %	0.48±0.02	0.27±0.1	3.03±0.04	3.72±0.02	4.06±0.02	4.06±0.03
Lactose g/L	/	/	45.5±0.3	45.6±0.2	45.8±0.3	45.2±0.3
Pectin (cold) %	3.6	5.2	0	1.18±0.01	6.38±0.01	6.98±0.01
Pectin (hot) %	/	/	0	1.04±0.02	2.36±0.01	2.99±0.2
Fat g/L	2.1±0.2	3.2±0.3	13±0.2	12.7±0.1	12.3±0.1	11.7±0.1
Ash %	1.9±0.03	2.2±0.01	0.4±0.03	0.73±0.02	0.96±0.02	1.13±0.01
Mineral salts mg/100 mL						
K	590	630	200±3	320±2	377±2	454±1
Na	/	/	28.5±1	21.4±1	21.3±1	21.4±1
Ca	570	625	286±2	326±1	352±2	354±3
Fe	18	22	0.17±0.01	0.19±0.01	0.19±0.01	0.19±0.01

Values represent Mean ± Sd ; n=3, confidence level $p \leq 0.05$, /: non-determined

Whatever the concentration of the dates used, the quantity of sugar that diffuses was constant, about

1.5%, which was added to the initial 4.5% of the milk. This result on the composition of milk-dates mixtures

corroborates the report of Belewu *et al.* (2014) and El-Sharnouby *et al.* (2014). Date palm is rich in dietary fiber; soluble dietary fibers contribute to the formation of a viscous gel and increase the viscosity of the milk-dates mixture. This gel decreases the rate of diffusion of sugar to the milk, which explains the constant content of sugar in the mixture. The majority of the proteins present in the dates diffuse towards the milk thus contributing to the protein enrichment of the mixture. Pectin substances are polysaccharides attached to carbohydrates and constitute plant cell walls and the date pulp. Pectin was found to accumulate in dates until it reaches the Rutab stage with minimal activity of pectin esterase enzyme (Mustafa *et al.*, 1986). The amount of these substances increased with increasing percentage of dates used. The diffusion of these substances at 30 °C was more intense, causing partial gelling of the mixture compared to the diffusion at 45 °C; this gelling only occurs after several hours of rest. The amount of lactose in the milk remains constant

since dates do not contain lactose. The fat content of the mixture decreases slightly with the increase in the amount of dates used. These substances can be absorbed by date fibers and retained on the filter; this can explain the increase in the density of the mixture. Dates are a good source of certain minerals (potassium and calcium), which explains the considerable ash content in the mixtures. The addition of dates to the milk improves the composition of the mixture in terms of ash and mineral salts.

Rheological characteristics

The stability and ability of the mixture to coagulate were determined by measuring TA at 30 °C and 45 °C. Dates are rich in mono sugars and organic acids. The TA of the mixtures increased with an increase in the percentage of the dates used (Figure 1).

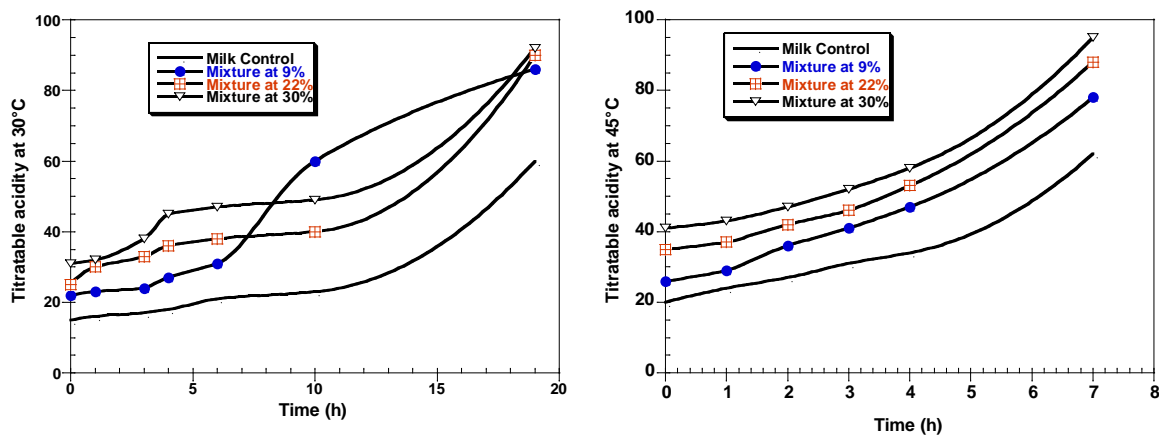
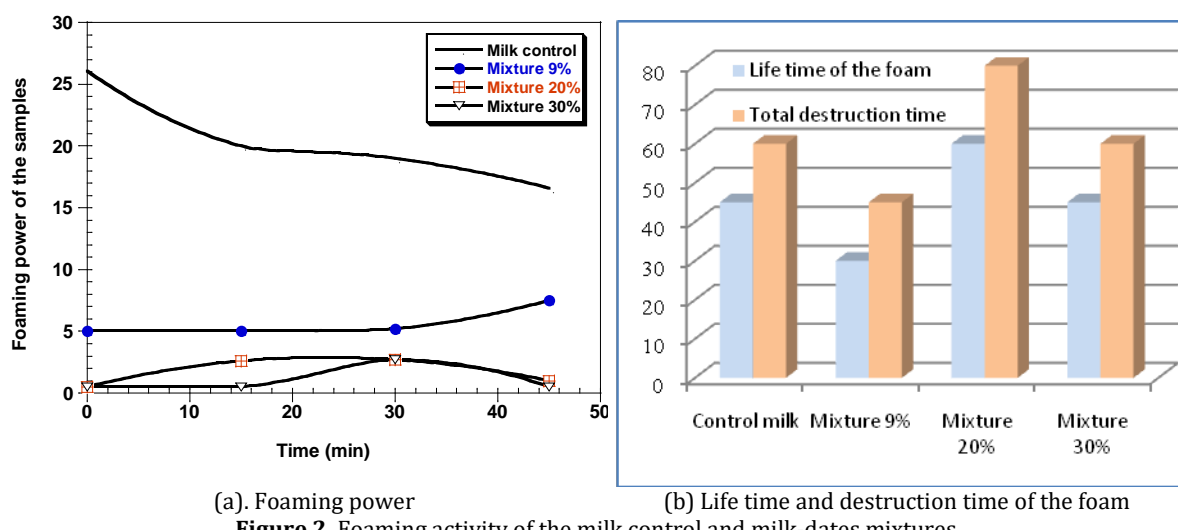


Figure 1. Evolution of the titratable acidity of milk and milk-dates mixture prepared at 30 °C and 45 °C.

For the control milk at 30 °C, the TA evolved from 15 ± 0.2 to 23 ± 0.1 °D after 10 hours and reached 60 ± 0.2 °D after 19 hours. At 45 °C, the TA evolved exponentially and reached 62 ± 0.1 °D after 7 hours. This acidification is the sign of coagulation of the samples. It seems that the mixture prepared at 30 °C remained stable for 19 hours while the mixture at 45 °C became a coagulum after 7 hours. Several substances diffused from the dates to the milk, which can be attributed to various technological and functional properties of the mixtures such as emulsifying power and foaming activity. The interaction between proteins and lipids is common in many food systems, and thus the ability of proteins to form stable emulsions is important. The emulsifying power of the milk control and the mixtures at 9, 20 and 30% was 60, 70, 80 and 85%, respectively. The emulsifying power increased gradually with increasing concentration of the dates used. Thus, considering these emulsifying properties, dates could be used as ingredients in emulsion-based food formulations such as dressing and mayonnaise,

where functional properties are especially important. Some food proteins are capable of forming good foams, and their capacity to form and stabilize foams depends on the type of protein, degree of denaturation, pH, temperature and whipping methods (Lqari *et al.*, 2005). The lifetime of the foam of the milk-dates mixture at 20% lasted for 60 min and the destruction of this foam was achieved after 80 min. The volume of the foam disappeared rapidly in the control milk and other mixtures at 9% and 30% (Figure 2). The foaming power of the control milk was highest compared with the mixtures, i.e. it was 26.8% at the beginning, and then decreased to 16.6% after 45 min. By contrast, in the presence of dates, the foaming power was very weak. These results indicate that the milk added to dates changes characteristics and becomes a totally different system. The dates bring substances that interact with milk caseins and fat, thus modifying their foaming effect. This characteristic can be applied in the formulation of foods in which the presence of foam is undesirable without the use of antifoam agents.



(a). Foaming power

Figure 2. Foaming activity of the milk control and milk-dates mixtures

(b) Life time and destruction time of the foam

Microbiological evaluation

Actually, milk and dairy products are a great medium for the growth of many spoilage and pathogenic microorganisms. TPC in the milk control was 3×10^4 CUF/mL. This value is in line with the findings of Joffin and Joffin (2003). For milk-dates mixture samples, TPC ranged from 3×10^4 to 4×10^4 CUF/mL. This is logical because the dates used were not packed and not sterilized and that cause bacterial contamination. The result of microbiological evaluation indicated complete absence of total coliforms, *Staphylococcus aureus*, and *Salmonella* in all milk samples. Yeasts and molds were found in the milk-dates mixtures and ranged from 24 for 9%, 70 for 20% and 110 yeasts/mL for 30% because these microorganisms could withstand the acidity of the mixture. The milk control was marked by a total absence of these microorganisms. All mixtures were of satisfactory hygienic quality and did not involve any risk of toxi-infection to consumers.

Sensory evaluation

The sensory evaluation of the samples was conducted to determine the acceptability of the product to consumers. The samples were evaluated for color, flavor and taste characteristics. Milk flavor was influenced by the presence of fat and other flavoring compounds present in the milk or imparted by dates. The richness of dates in flavoring components such as fructose improved the taste of the milk-dates mixture. The acceptability of flavor and color of the mixtures increased gradually with the percentage of the dates used. According to the results presented in Table 2, the mixtures at 20 and 30% of dates were best appreciated by panelists and had the best color and flavor, followed by the mixture at 9% and the milk control. According to the panel members, the taste of the mixture at 20% was best appreciated 80%, followed by mixture 9%, mixture 30% and the control. Our results are in agreement with the work of Belewu *et al.* (2014).

Table 2

Sensory evaluation of the milk control and milk-dates mixture

Sensory characteristics	Samples	Good	Acceptable	Bad
Color	Milk control	40	40	20
	Mixtures 9%	40	35	25
	Mixtures 20%	70	20	10
	Mixtures 30%	65	25	10
Flavor	Milk control	30	50	20
	Mixtures 9%	35	40	25
	Mixtures 20%	65	25	10
	Mixtures 30%	65	30	05
Taste	Milk control	45	45	10
	Mixtures 9%	60	20	20
	Mixtures 20%	80	15	05
	Mixtures 30%	55	30	15

Formulation of steamed yoghurt using milk-dates mixtures

Proximate composition

This study was carried out to determine the possibility of this new system (milk-dates mixture) to produce a fermented product (yoghurt). During incubation period at 45 °C, the TA of the milk control and milk with dates at 30% evolved, respectively, from 28 and 35 °D to 70 °D after 4.5 hours. For yoghurts manufactured with milk-dates mixtures at 9 and 20%, the TA increased from 35 to 80 °D after 4.5 hours of incubation. This can be explained by the richness of dates in sugars, especially glucose, which are transformed by lactic acid bacteria and produce more lactic acid. During the storage period at 4 °C, the TA of the CY gradually increased from 78 °D to 100 °D after 21 days, while the preparation of the yoghurts with milk-dates caused a slight increase in acidity from 85 at the first day of storage to the values ranging between 103 and 108 °D (Table 3). This acidity explains the low values of pH obtained for milk-dates mixture yoghurts compared with the control. The TA of CY increased

during the incubation period due to the utilization of residual sugars by viable lactic starters and production of lactic acid (Parmjit and Shinde, 2012). Proteolytic enzymes secreted by microorganisms degrade yoghurt proteins into free amino acids and contribute to an increase in acidity (Widyastuti and Febrisiantosa, 2014). Our results confirm the findings of several authors (Bachir Raho and Benattouche, 2013; Kucukoner and Tarakci, 2003), who found that the TA values increased with the storage time. According to Hess *et al.* (1997), the pH of the yoghurt should be in the range of 4 to 5. Our results are in agreement with the findings of Bachir Raho and Benattouche (2013), and Singh *et al.* (2011), who reported a decrease in the pH of yoghurt during the storage period. The dry matter was represented mainly by sugars, proteins, mineral salts, fats and vitamins of the yoghurt. The decrease in the level of these parameters was proportional to the duration of storage due to the use of these nutrients by ferments and microorganisms. Yoghurts manufactured with milk-dates mixtures preserved their nutritional elements after 21 days of storage.

Table 3
Results of the physico-biochemical characterization of steamed yoghurts

Parameters	Steamed yoghurts	Days of storage			
		1	7	15	21
pH at 25 °C	CY	4.7 ± 0.1	4.5 ± 0.2	4.3 ± 0.2	4 ± 0.2
	MY9	4.5 ± 0.2	4.2 ± 0.1	4 ± 0.2	3.8 ± 0.1
	MY20	4.5 ± 0.1	4.3 ± 0.1	4.1 ± 0.3	3.7 ± 0.2
	MY30	4.3 ± 0.2	4.1 ± 0.1	3.8 ± 0.1	3.5 ± 0.1
Titratable acidity (°D)	CY	78 ± 0.2	85 ± 0.1	92 ± 0.3	100 ± 0.2
	MY9	85 ± 0.3	91 ± 0.1	98 ± 0.1	108 ± 0.2
	MY20	84 ± 0.2	91 ± 0.1	98 ± 0.3	107 ± 0.1
	MY30	80 ± 0.1	88 ± 0.2	96 ± 0.2	103 ± 0.1
Dry Mater (%)	CY	17 ± 0.2	15 ± 0.3	12 ± 0.2	7 ± 0.2
	MY9	22 ± 0.3	19 ± 0.1	16 ± 0.3	12 ± 0.2
	MY20	25 ± 0.3	22 ± 0.3	18 ± 0.1	15 ± 0.1
	MY30	27 ± 0.3	24 ± 0.3	19 ± 0.1	17 ± 0.1
Total Proteins (%)	CY	4.4 ± 0.1	4.3 ± 0.3	4.1 ± 0.2	3.6 ± 0.3
	MY9	4.7 ± 0.2	4.6 ± 0.2	4.5 ± 0.1	4.1 ± 0.1
	MY20	4.9 ± 0.2	4.9 ± 0.1	4.7 ± 0.1	4.4 ± 0.2
	MY30	4.9 ± 0.1	4.8 ± 0.3	4.7 ± 0.3	4.3 ± 0.2
Total sugars (%)	CY	13 ± 0.2	11 ± 0.3	9 ± 0.3	6.5 ± 0.2
	MY9	15 ± 0.1	13 ± 0.3	11 ± 0.1	09 ± 0.2
	MY20	15 ± 0.4	14 ± 0.3	10 ± 0.4	10 ± 0.3
	MY30	16 ± 0.3	14 ± 0.2	12 ± 0.2	11 ± 0.1
Total Fat (g/L)	CY	15 ± 0.2	14.8 ± 0.1	14.3 ± 0.1	14.2 ± 0.1
	MY9	14.8 ± 0.2	14.6 ± 0.1	14.4 ± 0.2	14.1 ± 0.1
	MY20	14.9 ± 0.2	14.7 ± 0.1	14.2 ± 0.2	13.8 ± 0.1
	MY30	14.7 ± 0.2	14.3 ± 0.1	14.1 ± 0.2	13.7 ± 0.1
Ash (%)	CY	1.3 ± 0.1	0.8 ± 0.2	0.77 ± 0.2	0.62 ± 0.1
	MY9	1.7 ± 0.2	1.3 ± 0.1	1.3 ± 0.2	1.2 ± 0.1
	MY20	1.9 ± 0.3	1.6 ± 0.2	1.5 ± 0.1	1.5 ± 0.2
	MY30	2.1 ± 0.2	1.8 ± 0.1	1.8 ± 0.2	1.7 ± 0.1

Values represent Mean ± Sd; n=3, confidence level $p \leq 0.05$

Microbiological evaluation

Results of the microbiological analysis indicated a complete absence of total coliforms, *Staphylococcus aureus*, fecal streptococci and *Salmonella* in all types of yoghurt and throughout the storage period. This absence can be explained by the satisfaction of hygienic requirements, the effectiveness of heat treatments and the acidifying activity of the lactic ferments which inhibit the proliferation of these germs. As regards yeasts and molds, these microorganisms appeared in the first week of storage (5 yeasts/mL), and then this number increased to 7 yeasts/mL during the last week of storage for yoghurts manufactured with milk dates. Results of microbiological evaluation indicated good quality of the yoghurts. Our results of all yoghurts are in line with the findings of Olmedo *et al.* (2013).

Sensory evaluation

Yoghurt is a fermented milk product with a refreshing flavor, a slight sour taste and a smooth

viscous gel (Bodyfelt *et al.*, 1988). These sensory properties offer quality control criteria, and, therefore, yoghurt should be evaluated for flavor, color, taste, and texture. Yoghurt flavor is influenced by the presence of lactic acid and other flavoring compounds produced by the culture starter during the fermentation process. The texture of yoghurt is affected by the rate of acid production during the fermentation process, as well as by the fat content and presence of stabilizing agents such as gelatin, milk solids, and sugar. Heating the mix denatures whey proteins, increases the water-holding capacity of milk protein, and reduces syneresis in yoghurt (Hekmat and McMahon, 1992). The taste of yoghurt comes from the aromas produced by lactic ferments during storage, mainly diacetyl and butyric acid. According to the results, the MY20 and MY30 received the best scores from the members of the panel for their flavor, taste and color. The panelists gave the highest score for texture to the CY and MY9 (Table 4).

Table 4
Sensory evaluation of steamed yoghurts

Sensory characteristics	Steamed yoghurts	Good	Acceptable	Bad
Flavor	CY	45	35	20
	MY9	55	30	15
	MY20	75	25	/
	MY30	80	15	05
Taste	CY	50	35	15
	MY9	60	25	15
	MY20	80	15	05
	MY30	65	20	15
Texture	CY	75	15	10
	MY9	70	15	15
	MY20	45	35	20
	MY30	40	30	30
Color	CY	50	35	15
	MY9	50	30	20
	MY20	75	15	10
	MY30	70	20	10

4. Conclusion

This study showed that the combination of dates and milk as a new food system is stable, very rich in nutritional elements, of good microbiological quality and highly evaluated for its overall consumer acceptability. The date added to the milk changed characteristics and became a totally different system marked by an increase in emulsifying power and a decrease in foaming activity. The new milk-dates system was found to be able to produce steamed yoghurts of good quality and high acceptability to consumers.

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