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# SOME TRADITIONAL AND NEW SWEETENERS : CHARACTERIZATION AND POTENTIAL USE AS PIE FILLING

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## ABSTRACT

Four sweeteners (dates honey, treacle, glucose syrup and high fructose corn syrup "HFCS") were investigated. The sweeteners exhibited the following characteristics: Brix° (70.1-80.1); dry matter (71.5-82.3%); refractive index (1.4657-1.4915); pH (4.5-4.6) and viscosity (6500-10250 c.p.). Sugars spectrum by HPLC indicated that glucose (44.33%) and fructose (27.00%) are the main sugars in treacle. Glucose syrup possessed the highest content of polysaccharides (53.65%). Notwithstanding, dates honey and treacle exhibited higher contents of ash, mineral elements (Na, K, Ca, P, Mg, Fe and Cu) and vitamins (riboflavin and folic acid) than each of glucose syrup and HFCS.

The four sweeteners were mixed in a blend with roasted chickpea or/and roasted peanut as pie filling. Among 32 treatments, panelists prefered pies containing dates honey and HFCS and were scored as superior to the control (Pies without filling).

**Keywords:** Dates honey (Deps), Tracle, Glucose syrup, High fructose corn syrup (HFCS), Physical properties, Sugar pattern, Ash and Minerals, Riboflavin, Folic acid, Chick pea, Peanut, Pie filling.

## INTRODUCTION

Dates honey (*Deps*) and treacle are well known traditional sweeteners in the Middle East. The former is made by concentrating the dates syrup in open kettles to up to 80% total solids. On the other hand, treacle (known as black honey) is essentially the concentrated cane juice without removal of any sucrose. According to Alvarez (1987), treacle production started from ancient time in Egypt. Production of treacle is almost controlled by the experience and the practice of the treacle makers (Amin, 1997).

Magomedov (1990) has patented a method for production of a semi-manufactured sugar product for confectionery involves preparation of a sugar treacle syrup and modified starch, spray drying in an air stream at 170-180°C, mixing and final drying to form a powder. Moreover, treacle was utilized to produce a caramel mass (Krylova and Urakov, 1990).

Recently, biotechnology was applied to produce glucose syrup and HFCS by means of immobilized enzymes. Nowadays, such sweeteners are considered as a potential food sweeteners and play a key role in what so called dynamic rheology of liquid and semi-solid foods (Hill, 1991; Hill *et al*., 1996).

The present work was undertaken to investigate the physical and chemical properties of two traditional sweeteners (*i.e. Deps* and Treacle) along with two new sweeteners produced by biotechnology (*i.e.* Glucose syrup and HFCS). Such properties will be practically important from the technological point of view. Moreover, the work aimed to study the aforementioned sweeteners as a potential pie filling in a blend with ground roasted peanut or/and roasted chickpea to elevate the nutritional quality of the pie.

## MATERIALS AND METHODS

**Materials:**

Date honey (*Deps*) was kindly secured by the Egyptian Vineyards Company, Alexandria. High fructose corn syrup (HFCS) of 42% fructose as well as glucose syrup were kindly provided by the National Company for Maize Products, 10th of Ramadan City, Egypt. Treacle, roasted chickpea and roasted peanut were purchased from Alexandria local market. Both samples were ground in a Braun Multimix Grinder (Germany).

**Methods:**

**I- Analytical methods:**

Refractive index and total soluble solids of sweeteners were measured at 20°C using an Abbe' refractometer (Digital Refractometer Atago, Germany). The apparent viscosity was assessed at 20°C by a Brookfield viscometer (Model RVF 230 V, USA).

Brix degree and % dry substances were measured by Atago apparatus (Model RX-5000, Japan). The pH values of sweeteners were determined by pH-meter (Jenway 3310, England).

Sugars were identified and determined by high performance liquid chromatography (HPLC) using Waters HPLC (M 510, USA). The pressure applied was 500 psi and the column used was carbohydrate Aminex at 85°C. The refractive index detector (Atago, Model RX-1000, Japan) was used to monitor the column effluent.

**Preparation of samples for riboflavin and folic acid determination**:

The well mixed sample was weighed up to 4 g into a 150 – ml beaker . a volume of 25 ml of 0.1 N sulphuric acid were added, the beaker was covered with foil and autoclaved at 121 °C for 30 min. The mixture was cooled and the pH was adjused to 4.5 with 2 M sodium acetate solution. A weight of 0.3 g of Clara- distase was added and the mixture was incubated at 40 °C for 2 hr. After cooling, the mixture was transferred with to a 50 ml voluimeteric flask and the volume was completed with water. The mixture centrifuged (xg) for min.

**Analysis by HPLC:**

Riboflavin and folic acid were determined using a Shimadzu reverse phase column (Skim-Pack CLC-ODS-Serial No. 015113198), a SPD-6 AV uv-vis spectrophotometer detector and a Shimadzu C-R4 A chromatopac as a

recording data processor. The mobile phase was a mixture of methanol and deionized water (70:30, v/v).

A weighed sample was ignited in a muffle furnace at 550°C to a constant weight for ash determination (AOAC, 1980). Sodium and potassium were determined using flamephotometer (Gallenkamp) while calcium, magnesium, iron and copper were determined by Unicam Atomic Absorption Spectrophotometer (SP 1900, USA), according to the AOAC (1980). Phosphorus was determined colorimetrically (molybdenum blue method) as outlined in AOAC (1980).

**Preparation of pies:**

Pies were prepared according to what is currently applied in a famous bakery in Alexandria ( Personal communication) using the following ingredients:

| Ingredient | Quantity |
|---|---|
| Wheat flour (72% extraction ratio) | 10 Kg |
| Water | 2 L |
| Eggs | 60 egg |
| Dry active yeast | 100 g |
| Salt | 120 g |
| Baking improvers | 150 g |
| Butter (added prior to forming process) | 3 Kg |
| Filling | 20 g/pie |

All steps of baking process (i.e. dough making, cutting, forming, fermenting, baking and packaging) were carried out using a complete machinery line (Mondia, Forni, SRL., Italy). Dough was divided into pieces (pies) 75 g each and was baked at 270°C for 10 min. A total number of 32 treatments in addition to control (pies without filling) were investigated. The 32 treatments for pie filling were as follows:

**Group 1:** Sweetener : Chickpea at ratios (w/w) 1:1, 1.5: 1 and 1: 1.5.

**Group 2:** Sweetener : Ground peanut at ratios (w/w) 1:1, 1.5: 1 and 1: 1.5.

**Group 3:** Sweetener : Blend of chickpea and peanut at ratios (w/w) of 1:1:1 and 2:1:1.

The ratios used were found to be the most suitable in terms of fluidity and homogenity for filling.

**Evaluation of organoleptic properties of pies:**

The pies were introduced to 12 panelists whome were asked to evaluate the samples regarding flavour, consistency and overall acceptability using a hedonic scale of 10 points: 9-10 (excellent), 7-8 (good), (5-6) fair and below 5 (poor). Data of taste panel testing were subjected to the statistical analysis (ANOVA) and Duncan's multiple range test as outlined in Steel and Torrie (1980).

## RESULTS AND DISCUSSION

**Physical properties:**

Data presented in Table 1 indicate that Brix° for the four sweeteners under study (treacle, dates honey, glucose syrup and HFCS) ranged from 70.1 (HFCS) to 80.1 (treacle). The HFCS exhibited the least dry matter (71.5%) while treacle possessed the highest percent (82.3%). The leaset refractive index (RI) was 1.4657 for HFCS, while glucose syrup had the highest RI (1.4915).

**Table 1: Some physical properties of different sweeteners.**

| Properties | Dates honey | Treacle | Glucose syrup | HFCS |
|---|---|---|---|---|
| Brix° | 78.9 | 80.1 | 78.7 | 70.1 |
| Dry matter (%) | 80.6 | 82.3 | 79.2 | 71.5 |
| Refractive index | 1.4878 | 1.4857 | 1.4915 | 1.4657 |
| PH | 4.6 | 4.5 | 4.6 | 4.5 |
| ViscosityC-poise/20°C | 9600 | 10250 | 7800 | 6500 |

The pH values for the aforementioned sweeteners were almost comparable since pH values varied only in a range of 0.1 unit. Treacle exhibited the highest viscosity (10250 c.p.) on contrary to HFCS which had the lowest viscosity (6500 c.p.).

It is worth to mention that diversity of these sweeteners in their physical properties is in favour of manipulation the dynamic rheology of filling materials in which such sweeteners can be incorporated.

**Sugar composition**

Data in Table 2 and Fig 1 indicate that the predominant sugars in dates honey are glucose and fructose (44.33 and 28.68%, respectively), while for treacle, sucrose and fructose were the main sugars (42.78 and 27.00%, respectively).

On the other hand, glucose syrup was different from the other sweeteners regarding polysaccharides content being 53.64% for glucose syrup as compared to a range of 0.64 to 4.38% polysaccharides for the other three sweeteners. The HFCS had 56.26% glucose and 42.2% fructose.

**Table 2: Sugar spectrum of the different sweeteners.**

| Sugars | Dates honey | Treacle | Glucose syrup | HFCS |
|---|---|---|---|---|
| Polysaccharides | 4.378 | 3.451 | 53.462 | 0.640 |
| Dextrins | 2.624 | 1.235 | 11.736 | 0.456 |
| Raffinose | 2.976 | 2.105 | - | - |
| Maltose | 2.081 | 1.900 | 16.19 | 2.426 |
| Sucrose | 3.139 | 42.78 | - | - |
| Glucose | 44.332 | 20.610 | 18.432 | 56.258 |
| Aldo-saccharides | 1.746 | 0.911 | - | - |
| Fructose | 38.677 | 27.00 | - | 42.211 |
| Ketosaccharides | 0.047 | 0.008 | - | - |

**Fig.1 : High-performance liquid chromatograms of dates honey, treacle, glucose syrup and high fructose corn syrup HFCS.**

Dextrin content ranged from 0.46% for HFCS to 11.74% for glucose syrup while raffinose content varied from zero (glucose syrup and HFCS) to 2.98% (dates honey). Glucose syrup exhibited the highest maltose content being 16.19% on contrary to treacle which had 1.9% maltose.

It was obvious that treacle possessed the highest sucrose content (42.78%) followed by dates honey (3.14%) while glucose syrup and HFCS did not reveal detectable amounts neither for sucrose nor for aldosaccharides.

**Ash and mineral elements:**

The four sweeteners under study were found, to be different in terms of ash and mineral content. It was clear that dates honey and treacle possessed higher ash content (2.35 and 1.43%, respectively) as compared to any of glucose syrup (0.03%) and HFCS (0.02%) as it can be seen from data presented in Table 3. Moreover, dates honey and treacle exhibited higher mineral content (mg/100 g) than glucose syrup and HFCS : Na (38.64- 33.33 versus 1.34-1.82), K ( 516.6-279.2 vesus 3.36-1.45), Ca (72.21-284.45 versus 0.77-0.78), P (59.37-64.83 versus 1.655-0.199), Mg (6.77-7.55 versus 0.22-0.25), iron (3.34-5.25 versus 0.12-0.14) and copper (0.20-0.99 versus 0.02). Such differences can be attributed to diversity of raw materials utilized in the production of dates honey (dates), treacle (sugar cane) and HFCS (corn).

**Vitamins**

Data presented in Table 3 (and Fig.2) indicate that dates honey possessed the highest riboflavin (19.59 mg/L) and folic acid (28.02 mg/L) content followed by treacle (11.26 and 13.43 mg/L, respectively) and HFCS (7.49 and 8.30 mg/L, respectively), while glucose syrup exhibited the lowest contents of riboflavin (0.88 mg/L) and folic acid (0.62 mg/L). Consequently, it can be concluded that dates honey and treacle, in addition to their main function as sweeteners are considered as a relative good source of riboflavin and folic acid as compared to the other two sweeteners especially glucose syrup.

**Table 3: Ash, some mineral element composition and vitamins of the different sweeteners.**

| Components | Samples | | | |
|---|---|---|---|---|
| | Dates honey | Treacle | Glucose syrup | HFCS |
| Ash (%) | 2.35±0.03 | 1.43±0.02 | 0.033±0.002 | 0.018±0.001 |
| | | | | Mineral Element mg/100 gm |
| K | 516.6±4.7 | 279.2±5.1 | 3.36 ±0.01 | 1.45±0.01 |
| Na | 38.64±0.86 | 33.33±0.54 | 1.34±0.02 | 1.83±0.01 |
| Ca | 72.21 ±1.73 | 283.35±2.88 | 0.77±0.03 | 0.78 ±0.02 |
| P | 59.37±1. 37 | 64.83±1.15 | 1.655±0.05 | 0.199±0.01 |
| Mg | 7.55±0.04 | 6.77±0.03 | 0.25±0.01 | 0.22±0.01 |
| Fe | 3.34±0.01 | 5.25±0.01 | 0.14±0.00 | 0.02±0.00 |
| Cu | 0.99±0.04 | 0.20±0.01 | 0.02±0.00 | 0.02±0.00 |
| Vitamins (mg/L) | | | | |
| Riboflavin | 19.585 | 11.26 | 0.878 | 7.489 |
| Folic acid | 28.024 | 13.432 | 0.617 | 8.297 |

**Fig.2 : High-performance liquid chromatograms of standard mixture of folic acid and riboflavin.**

**Table 4: Sensory evaluation for the pies containing different sweeteners and ground legumes as filling material.**

| Sample | Flavour (out of 10) | Consistency (out of 10) | Overall Accep. (out of 10) |
|---|---|---|---|
| Treacle | | | |
| + Chickpea | | | |
| 1 : 1 | 7.5 ± 0.2$^{cd}$ | 8.5 ± 0.3 | 7.8 ± 0.2$^{bc}$ |
| 1.5 : 1 | 7.4 ± 0.1$^{cd}$ | 8.8 ± 0.2 | 7.8 ± 0.1$^{bc}$ |
| 1 : 1.5 | 6.6 ± 0.2$^{e}$ | 8.6 ± 0.2 | 7.1 ± 0.1$^{e}$ |
| + Peanut | | | |
| 1 : 1 | 7.8 ± 0.3$^{bc}$ | 8.4 ± 0.1 | 8.0 ± 0.1$^{abc}$ |
| 1.5 : 1 | 7.4 ± 0.1$^{cd}$ | 8.4 ± 0.1 | 7.9 ± 0.2$^{bc}$ |
| 1 : 1.5 | 7.7 ± 0.1$^{bc}$ | 8.0 ± 0.2 | 7.7 ± 0.1$^{cd}$ |
| HFCS | | | |
| + Chickpea | | | |
| 1 : 1 | 7.4 ± 0.2$^{cd}$ | 8.4 ± 0.2 | 7.8 ± 0.1$^{bc}$ |
| 1.5 : 1 | 7.8 ± 0.2$^{bc}$ | 8.2 ± 0.2 | 8.0 ± 0.1$^{abc}$ |
| 1 : 1.5 | 7.1 ± 0.2$^{de}$ | 8.0 ± 0.2 | 7.6 ± 0.1$^{cd}$ |
| + Peanut | | | |
| 1 : 1 | 8.8 ± 0.1$^{a}$ | 9.1 ± 0.3 | 8.0 ± 0.3$^{ab}$ |
| 1.5 : 1 | 9.1 ± 0.2$^{a}$ | 8.6 ± 0.3 | 8.5 ± 0.1$^{a}$ |
| 1 : 1.5 | 9.0 ± 0.2$^{a}$ | 8.4 ± 0.1 | 8.3 ± 0.3$^{ab}$ |
| Glucose syrup | | | |
| + Chickpea | | | |
| 1 : 1 | 6.6 ± 0.1$^{e}$ | 8.0 ± 0.2 | 7.6 ± 0.2$^{e}$ |
| 1.5 : 1 | 6.9 ± 0.2$^{de}$ | 8.2 ± 0.2 | 7.0 ± 0.1$^{e}$ |
| 1 : 1.5 | 6.5 ± 0.2$^{e}$ | 8.0 ± 0.1 | 7.0 ± 0.1$^{e}$ |
| + Peanut | | | |
| 1 : 1 | 7.6 ± 0.1$^{c}$ | 8.5 ± 0.3 | 7.5 ± 0.1$^{cd}$ |
| 1.5 : 1 | 7.9 ± 0.2$^{bc}$ | 8.5 ± 0.2 | 7.8 ± 0.1$^{bc}$ |
| 1 : 1.5 | 7.5 ± 0.2$^{cd}$ | 8.3 ± 0.3 | 7.2 ± 0.2$^{de}$ |
| Dates honey | | | |
| + Chickpea | | | |
| 1 : 1 | 7.1 ± 0.2$^{de}$ | 8.5 ± 0.1 | 7.3 ± 0.2$^{de}$ |
| 1.5 : 1 | 7.4 ± 0.1$^{cd}$ | 8.5 ± 0.3 | 7.7 ± 0.2$^{cd}$ |
| 1 : 1.5 | 7.4 ± 0.1$^{cd}$ | 8.0 ± 0.1 | 7.6 ± 0.2$^{cd}$ |
| + Peanut | | | |
| 1 : 1 | 8.2 ± 0.2$^{b}$ | 8.7 ± 0.2 | 7.9 ± 0.2$^{bc}$ |
| 1.5 : 1 | 8.8 ± 0.2$^{a}$ | 8.7 ± 0.2 | 8.3 ± 0.3$^{ab}$ |
| 1 : 1.5 | 8.8 ± 0.1$^{a}$ | 8.4 ± 0.2 | 8.0 ± 0.2$^{abc}$ |
| Treacle | | | |
| Treacle : Chickpea : Peanut | | | |
| 1 : 1 : 1 | 7.3 ± 0.1$^{d}$ | 8.7 ± 0.1 | 7.7 ± 0.1$^{c}$ |
| 2 : 1 : 1 | 7.8 ± 0.2$^{bc}$ | 8.3 ± 0.3 | 8.0 ± 0.3$^{bc}$ |
| HFCS | | | |
| HFCS : Chickpea : Peanut | | | |
| 1 : 1 : 1 | 8.2 ± 0.1$^{ab}$ | 8.8 ± 0.1 | 8.5 ± 0.2$^{a}$ |
| 2 : 1 : 1 | 8.3 ± 0.1$^{a}$ | 8.7 ± 0.2 | 8.4 ± 0.2$^{a}$ |
| Glucose syrup | | | |
| Glucose : Chickpea : Peanut | | | |
| 1 : 1 : 1 | 7.6 ± 0.2$^{cd}$ | 8.2 ± 0.1 | 8.1 ± 0.1$^{bc}$ |
| 2 : 1 : 1 | 8.0 ± 0.3$^{ab}$ | 8.2 ± 0.1 | 8.1 ± 0.1$^{bc}$ |
| Dates honey | | | |
| Dates honey: Chickpea: Peanut | | | |
| 1 : 1 : 1 | 7.9 ± 0.1$^{ab}$ | 8.5 ± 0.2 | 8.4 ± 0.1$^{ab}$ |
| 2 : 1 : 1 | 8.1 ± 0.1$^{a}$ | 8.3 ± 0.2 | 8.6 ± 0.2$^{a}$ |

| | | | |
|---|---|---|---|
| Control (Without filling materials) | $7.8 \pm 0.1^{bc}$ | $8.6 \pm 0.3$ | $8.0 \pm 0.1^{bc}$ |

**Values in a column not sharing the same superscript are significantly different at P < 0.01.**

**Sensory properties of pies:**

Table 4 shows the data of sensory evaluation of pies containing different sweeteners in a blend with chickpea or/and peanut. Statistical analysis of these data did not explore any significant difference regarding consistency among the 32 treatments along with the control. In contrast, panelists were capable of tracing highly significant differences with respect to flavour and overall acceptibility among the tested pies. In this regard, the HFCS and dates honey which were incorporated in filling materials were scored to be superior to both treacle and glucose syrup. Moreover, panelists statistically prefered the filling material in which peanut rather than chickpea was incorporated, but, blend of chickpea and peanut was scored to be superior to chickpea only.

## CONCLUSION

In a conclusion, the HFCS and dates honey can be potentially used as a pie filling in a blend with peanut or/and chickpea and thereby elevating the nutritional quality of the resultant pies.

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## بعض المحليات الشائعة والجديدة : الخواص والاستفادة منها كمادة حشو للفطائر

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تم فى هذا البحث دراسة أربعة محليات وهى عسل البلح والعسل الأسود وشراب الجلوكوز. وشراب الذرة عالى الفركتوز . وقد شملت الدراسة التى أجريت على هذه المحليات تقدير قيمة البركس (1,70 - 80,1 ) والمواد الصلبة ( 71,5% - 82,3% ) ومعامل الانكسار (1,4657 - 1,491) ودرجة الحموضة (4,5 - 4,6 ) واللزوجة ( 6500 - 10250 سنتيبواز ) ، هذا وقد أوضحت النتائج المتحصل عليها بإستخدام كروما توجرافيا السائل عالي الكفاءة ان كل من الجلوكوز (44.33 %) والفركتوز ( 27.00 % ) هما المكونان الرئيسيان في العسل الأسود بينما كانت السكاكر العديدة (53.65 %) هي المكون الأساسي في شراب الجلوكوز . ومن جهة آخرى فقد وجد أن عسل البلح والعسل الأسود هما الأعلى في محتواهما من الرماد والمعادن ( الصوديوم والبوتاسيوم والكالسيوم والفوسفور و الماغنيسيوم والحديد والنحاس ) وفيتامينات الريبوفلافين وحمض الفوليك وذلك بالمقارنة بكل من شراب الذرة عالي الفركتوز وشراب الجلوكوز . هذا وقد تم خلط تلك المحليات الأربع مع محمص الحمص و/ أو محمص الفول السوداني بنسب مختلفة لاستخدامها كمادة حشو في الفطائر . وقد أظهرت نتائج الأختبارات العضوية الحسية تفضيل المحكمين للفطائر المحتوية على عسل البلح وشراب الذرة عالي الفركتوز.