



**Knowledge Transfer Partnership Project Report**

**Western Commodities Ltd. and Plymouth University**

**October 2014**

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## **KTP Project Report: Western Commodities Ltd. with Plymouth University**

### **Project Summary**

Western Commodities Ltd. undertook a KTP (Knowledge Transfer Partnership) with Plymouth University between January 2014 and October 2014. The recruited associate, Alison Bengler, worked with technical, production and commercial employees at Western Commodities Ltd, and academic supervisors and laboratory technicians at Plymouth University to complete the project.

Objectives of the project included collating existing research into the nutritional properties of dates (*Phoenix dactylifera*) as well as carrying out nutritional analysis on dates that Western Commodities Ltd. imports and processes. Glycaemic index testing carried out at Plymouth University identified date varieties with a low GI. Results of the mineral analysis demonstrates that the dates imported by Western Commodities Ltd. have higher mineral levels than previously thought.

In addition to research, new product development (NPD) formed a core part of the project. Six date bar recipes were developed from concept through to launch, which included the preparation of technical information to support product functionality claims, as well as the implementation of new QA systems to support the production of the new products. Glycaemic index testing carried out on two of the bars confirmed the products to have a low GI. Although an extensive study into the value of the date bars as sports nutrition did not produce scientific data suitable to make product claims, it highlighted a number of important considerations for future sports nutrition studies, as well as useful subject feedback about the date bars.

The third theme of the project was to assist with the commissioning of the rehydration room, through the collection and analysis of data associated with rehydration. Date rehydration is now an important process in the factory and has helped Western Commodities Ltd. to produce date paste which meets customer specification.

## **Report Content**

This report is divided into 3 sections, reflecting the main tasks of the KTP:

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## 1. Research into the Nutritional Properties of Dates and Date Bars

### 1.1 Summary of Existing Research

Existing research regarding the nutritional properties for dates is wide ranging and investigates various aspects of the chemical composition and functional properties of dates, from vitamin and mineral content to glycaemic index (GI). Published research has been predominantly carried out in date-growing countries, on different varieties and maturities of dates.

Key learnings from published research:

- The high nutritional value of dates can be attributed to the high fibre content, which has been reported to be between 4 g and 17 g per 100 g dates, with an average of 8 g per 100 g dates. The fibre content depends on the variety of date and degree of ripeness. As dates ripen, the moisture content decreases whilst the fibre content increases. It has been proposed that the high fibre content of dates may help to lower cholesterol.
- Dates have a high carbohydrate content which is comprised predominantly of simple sugars glucose and fructose, and trace amounts of sucrose. Some varieties of dates contain significant amounts of sucrose, namely the Tunisian date Deglet Nour.
- Some dates are low GI, which means they can be eaten by diabetics as part of a healthy balanced diet. The GI can be attributed partly to the high fibre content and the balance of glucose and fructose.
- Dates are a moderate source of some vitamins; vitamins B<sub>1</sub>, B<sub>6</sub>, B<sub>9</sub>, B<sub>2</sub>, B<sub>3</sub>, A and C have been found in dates.
- Dates are a rich source of a variety of minerals, including iron, copper, manganese, copper, potassium, magnesium and phosphorous. The mineral content varies according to the variety and maturity of the date.
- Dates are low in fat and protein, although some essential amino acids can be found in dates.

### 1.2 Proximate Analysis

The chemical composition of a number of different dates imported by Western Commodities was analysed at Plymouth University and compared against published data (Table 1). Varieties analysed include Aseel, Bengum Jangi, Deglet Nour, Noir Dor and Sayer.

Generally the results of analysis carried out on dates imported by Western Commodities shows that the values are in line with previously reported values. The fibre content is slightly lower than the published data but this more likely to reflect limitations within the method of analysis rather than the actual fibre content. There are various methods that can be used; the more efficient the method at extracting the fibre from the sample, the higher the reported value will be.

**Table 1.** Comparison of published data and nutritional analysis carried out by Western Commodities Ltd.

	Published Data (g per 100 g dates)		Western Commodities Analysis (g per 100 g dates)	
	<i>Range</i>	<i>Average</i>	<i>Range</i>	<i>Average</i>
Fat	<0.1 – 3.3	0.5	<0.1	<0.1
Carbohydrates	68 - 84	78	-	-
Total Sugars	36 - 80	65	56 - 63	60
Protein	0.4 – 3.3	1.6	0.9 – 1.6	1.2
Fibre	3.9 – 17.7	9.0	3.3 – 3.6	3.4

### 1.3 Mineral Analysis

Like many companies in the food industry, Western Commodities has previously relied upon the popular McCance & Widdowson’s reference book for minerals levels. Examining published research revealed the high mineral content reported in across different varieties of dates from different origins. Mineral analysis was therefore carried out at Plymouth University on five different varieties of dates imported by Western Commodities Ltd.

We are excited to report that our analysis has shown that our dates are an even greater source of minerals than published data would indicate (Table 2). The values reported below demonstrate that dates can be a significant source of minerals in the diet.

Findings of particular interest include:

- The mean result for iron is 2.75 times greater than previously published results
- The mean result for zinc is 2.3 times greater than previously published results
- The mean result for calcium is 1.4 times greater than previously published results.
- The mean result for magnesium is 1.4 times greater than previously published results

- The mean result for manganese is 1.3 times greater than previously published results
- The mean result for copper is 1.2 times greater than previously published results

**Table 2.** Comparison of published data and mineral analysis carried out by Western Commodities Ltd. Values reported as the mean value for the five varieties of dates analysed.

	Western Commodities Analysis		McCance & Widdowson's
	mg per 100 g dates	% NRV	mg per 100 g dates
Iron	3.93	28	1.3
Potassium	696	35	700
Magnesium	55	15	41
Calcium	65	8	45
Copper	0.37	37	0.26
Manganese	0.51	26	0.3
Zinc	0.69	7	0.4
Phosphorous	50	7	60

For the full report, see appendix.

#### 1.4 Antioxidant Analysis

An antioxidant is a molecule or compound that inhibits the oxidation of other molecules. Oxidation reactions can produce free radicals, which can be highly reactive and cause cellular damage. By preventing oxidation reactions, antioxidants play an important role in human health and food stability. There are various methods that can be utilized to assess the antioxidant activity of dates, which aim to quantify and characterise the antioxidant compounds. Many studies have focused on the antioxidant status of dates. These studies have investigated the antioxidant level of dates, and also of food products containing dates and date products (pastes, powders, syrups etc.). Reported values of antioxidant activity are wide ranging, which may reflect differences in the methods use and date varieties analysed.

Antioxidant analysis formed part of the research carried out during the KTP. For the full report, see appendix. Total Phenolic Content (TPC) is a common technique that can be used to indicate the antioxidising capacity of a sample, by measuring the amount of phenolic compounds (which are antioxidants) present in a sample. The results of this test (Table 3) confirmed the presence of antioxidants in dates. These results are in agreement with some published results; analysis carried out on dates from Tunisia ranged from 209 – 448 mg GAE in 100 g fresh weight (Saafi et al., 2009).

Ferric Reducing Antioxidising Capacity (FRAP) was also used to measure antioxidant capacity. Previous research has reported a value of 0.94 mmol FRAP per 100 g fresh weight of tamer (dried) dates (Allaith, 2008). The results of the analysis carried out by Western Commodities Ltd. (Table 3) are higher than these previously reported values.

In addition to TPC and FRAP, Trolox Equivalent Antioxidant Capacity (TEAC) was another method used to establish the antioxidising capacity of the dates imported by Western Commodities. Biglari et al. (2008) reports TEAC as 23 – 41 µmol Trolox equivalents (TE) per 100 g of soft dates (dry weight), whilst Saafi et al. (2009) reported values ranging between 867 and 1148 µmol TE / 100 g dates. The dates analysed in this project had values much higher than those previously reported (Table 3).

**Table 3.** TPC, FRAP, and TEAC of dates imported by Western Commodities Ltd, expressed as gallic acid equivalent (GAE) per 100g fresh weight, mmol FRAP per 100 g fresh weight and µmol Trolox Equivalent (TE) per 100 g fresh weight respectively.

Sample	TPC	FRAP	TEAC
	mg GAE / 100 g dates	mmol FRAP / 100 g dates	µmol TE / 100 g dates
Aseel	349	16	7354
Noir Dor	190	8	6721
Deglet Nor	203	9	6127
Sayer	137	7	7196
Bengum Jangi	199	11	9533
Date Syrup	239	10	5176

Positive correlation ( $R^2 = 0.8552$ ) was found between FRAP and TPC. This demonstrates the reliability of the methods. TEAC results did not correlate with TPC or FRAP. In descending order, the level antioxidant activity according to FRAP and TPC was Aseel > Date Syrup > Sayer > Deglet Nour and Bengum Jangi > Noir Dor.

There is a vast consensus in the published research that has been reviewed as part of this KTP, that the inclusion of date and date products in food would enhance the food's antioxidant status. These conclusions are based on the analysis of the antioxidant capacity of the dates, which are consistently measured as high. Variables which could be considered controllable (e.g. cultivar; stage of ripeness at harvest; method of antioxidant analysis) and uncontrollable (e.g. climatic influences) impact upon the antioxidant capacity of the dates. Therefore, dates selected for inclusion in food product should be analysed beforehand to ensure that the antioxidant capacity has not been compromised during cultivation, storage, or due to natural

variation among cultivars. Identifying cultivars with the highest level of antioxidants would increase the chances of successful application.

The next step in developing a market for the use of dates in food product would be to trial dates in various applications, such as dairy products (e.g. milk, yoghurts), confectionary (e.g. fruit bars), bakery (e.g. bread, cookies and cakes). The purpose of these trials would be to demonstrate enhanced:

- Product stability and shelf life
- Nutritional profile
- Organoleptic quality

Should the trials be successful, they would demonstrate the versatility of dates as a health promoting functional ingredient. Two final year students at Plymouth University will be carrying out research projects into the antioxidant properties of dates during the academic year of 2014 – 2015. Dates will be supplied by Western Commodities Ltd.

### 1.5 Glycaemic Index and Satiety Testing

With reference to the report “*Glycaemic Index and Satiety Index Testing of Dates, Date Bars and Date Syrup*” written by Alison Bengler (October 2014) the following abstract provides a brief summary of the study that took place. For the full report, see appendix.

**Background:** The glycaemic index (GI) is a system of classifying foods according their impact on blood sugar levels. Foods classified as low GI are digested and absorbed by the body slower than foods classified as high GI. Since a number of factors influence the impact of food on blood glucose levels, the GI value of a food is an easy and convenient way for consumers to make healthy food choices. The GI classification system is of particular interest to diabetes sufferers. Consumption of low GI foods can help to moderate blood sugars levels as part of a healthy diet. The satiety index (SI) is a system of classifying foods according to their impact on perception of satiety, in relation to a reference food (typically glucose or white bread). This information can be used by consumers to identify foods that are more likely to make them feel fuller for longer, and may help to reduce snacking between meals. The purpose of this study is to establish the GI value and SI of dates, date syrup and date bars.

**Methods:** 11 healthy subjects (three male, eight female) took part in the study, fasting 10 - 12 hours prior to commencing each testing session. Test samples (three varieties of date, two date bars and date syrup) consumed by the subjects contained 50 g of carbohydrates. The reference sample was 50 g of dextrose.

Blood glucose measurements were carried out using capillary blood at defined time intervals over a period of 130 minutes following the consumption of the test sample or reference sample. At the same intervals, subjects recorded their perception. The area under the curve (AUC) was calculated for all test samples and reference samples results for both GI and SI. The AUC of test samples was measured against the mean results for AUC of reference samples and reported as a percentage.

**Results:** The GI values of the dates tested were  $53.8 \pm 17.7$ ,  $60.6 \pm 16.9$  and  $50.4 \pm 24.7$  (mean  $\pm$  SD) for Sayer, Aseel and Deglet Nour dates respectively, which means that Sayer and Deglet Nour dates are classified as low GI (< 55), whilst Aseel dates are classified as medium GI (55 – 69). Both date bars tested had a low GI, with values of  $51.9 \pm 27.7$  and  $43.7 \pm 20.6$  for the double chocolate and mixed nuts flavours respectively. Date syrup had a medium GI with value of  $63.3 \pm 23.3$ . The SI of the dates ranged from  $178 \pm 114$  to  $193 \pm 192$ , whilst the SI of date bars was between  $208.3 \pm 178.1$  and  $320.6 \pm 367.0$ . The SI of date syrup was much lower at  $117 \pm 72$ .

**Conclusions:** The results partly confirm but also differ slightly from published research regarding the glycaemic index of dates, which highlights the complexity of establishing GI values for different foods. Although the results show that two of the date varieties and both date bars are low GI, the shape of the curves produced from the blood glucose excursions are very different. Evaluating the shape of the curve could help to establish the suitability of the test samples for different target consumers (namely diabetics and athletes). In this instance, the results suggest that the rapid elevation of blood glucose after the consumption of dates may render them suitable for consumption during high intensity endurance exercise, whilst the date bars may be better suited to lower intensity endurance exercise. The SI of the test samples shows that the date bars elicited the highest perception of satiety, which could be attributed to the presence of fat and protein in the product formulations.

## 2. New Product Development

### 2.1 Recipe Development

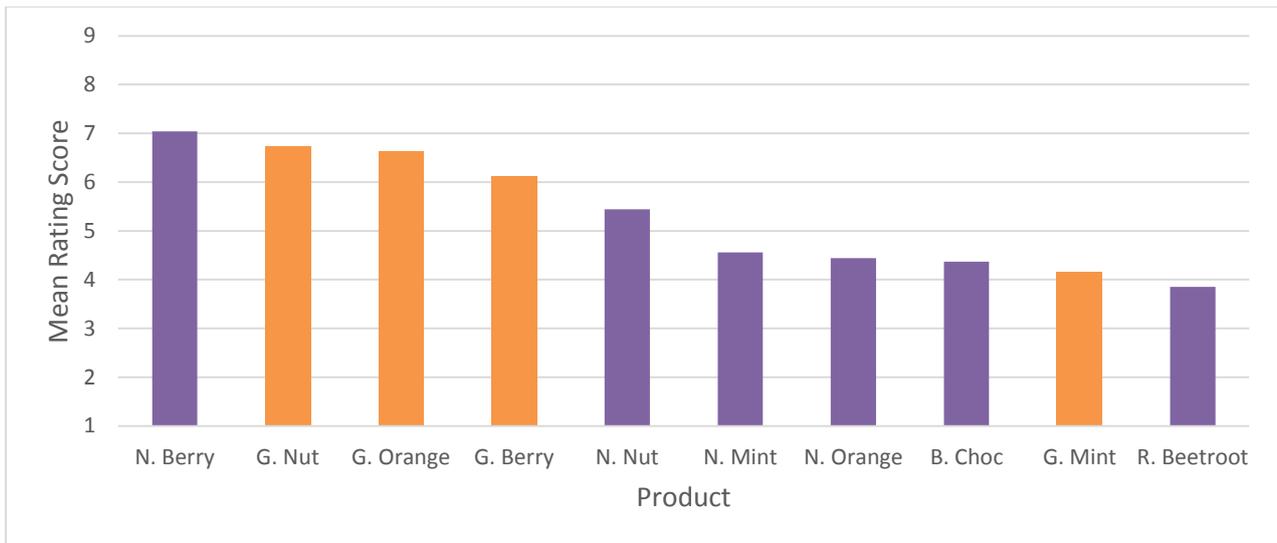
A key task of the KTP was to capitalise on the nutritional benefits of dates to develop a healthy snack product with specific nutrition claims. Four recipes were originally developed comprising predominantly of dates and nuts. Date syrup was added for sweetness and rice bran was used to provide texture and increase the fibre content. Double Chocolate and Cherry and Maple Syrup were two variants added to the range at later date. Test samples were produced from the new NPD kitchen on site.

**Table 4.** Date bar formulations

<b>Product</b>	<b>Ingredients</b>
Mixed Nuts	Dates, Mixed Nuts 30%, Rice Bran, Raisins, Date Syrup, Salt
Berry	Dates, Cashews, Rice Bran, Raisins, Date Syrup, Raspberries 1.5%, Flavouring
Choc Mint	Dates, Cashews, Rice Bran, Chocolate 8% (Cocoa Mass, Sugar, Cocoa Butter, Fat-Reduced Cocoa Powder, Emulsifier: Soya Lecithin), Date Syrup, Flavouring
Choc Orange	Dates, Cashews, Raisins, Rice bran, Chocolate 8% (Cocoa Mass, Sugar, Cocoa Butter, Fat-Reduced Cocoa Powder, Emulsifier: Soya Lecithin), Date Syrup, Orange Peel 5%, Flavouring
Double Choc	Dates, Cashews, Chocolate 20% (Cocoa Mass, Sugar, Cocoa Butter, Fat-Reduced Cocoa Powder, Emulsifier: Soya Lecithin), Rice Bran, Date Syrup, Flavouring
Cherry and Maple	Dates, Cashews, Rice Bran, Cherry Juice Concentrate 5%, Maple Syrup 2.5%, Freeze-dried Cherries 1.5%, Flavouring

## 2.2 Benchmarking

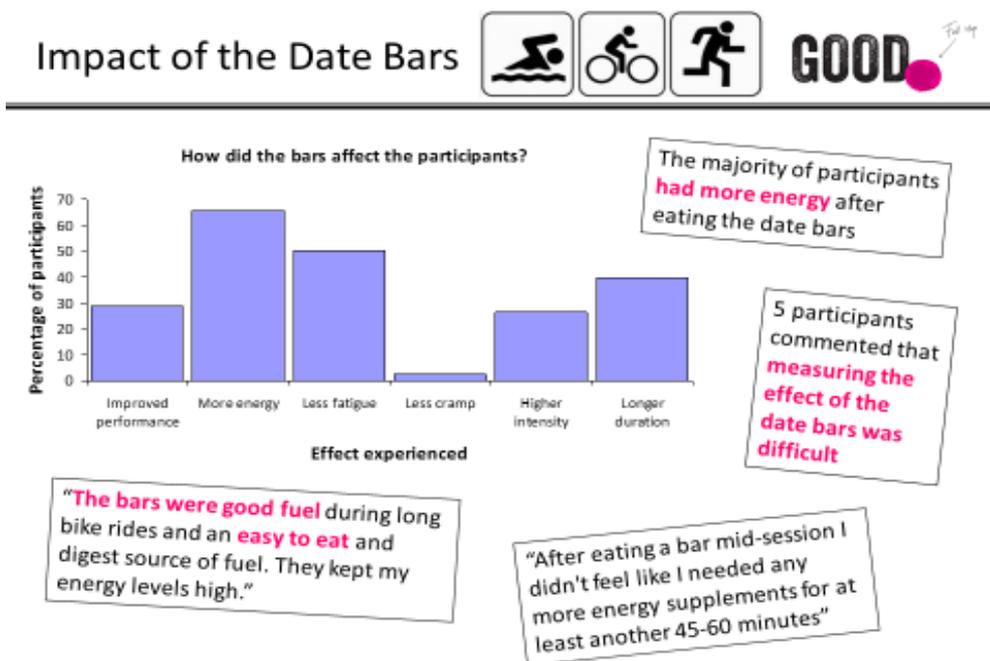
As part of the development process, the proposed recipes were benchmarked against brand leaders (Fig. 1). The benchmarking highlighted weakness within the recipes, which were redeveloped accordingly to ensure that date bars produced by Western Commodities Ltd. would be market leaders on taste. Redevelopments included increasing the natural flavouring in the Berry variant, as it was considered not strong enough. Benchmarking also highlighted that the Chocolate Mint is a polarising flavour; some people loved it whilst others did not like it at all. For the full report, see appendix.



**Fig. 1** Bar chart to demonstrate mean rating on scale of 1 to 9, where 1 = not very appealing, 9 = very appealing. (Prefix 'N', 'B' and 'R' are competitors, 'G' is a Good fullstop bar)

### 2.3 Product Sampling

Since the date bars developed by Western Commodities Ltd are a nutrient dense source of energy, a key target consumer will be recreational and club athletes. Local running, cycling and triathlete clubs were sent packs of samples to test during training and competitions along with feedback questionnaires. 38 completed questionnaires were returned. A report was produced summarising the key outcomes of the product sampling, which highlighted. Figure 2 summarises some of the comments made by the athletes.



**Fig. 2.** A slide extracted from the Consumer Sampling Report

For the full report, see appendix.

## 2.4 Product Testing with Athletes

With reference to the report "*An evaluation of the physiological response of dates and date bars as a source of energy during an endurance event (40 km ergometer time trial)*" written by Alison Bengler (October 2014), the following abstract provides a brief summary of the study that took place. For the full report, see appendix.

**Background:** Previous research has documented that carbohydrate feeding before and during exercise can positively impact upon performance in events lasting longer than one hour in duration. The objective of this pilot study was to investigate the influence of glycogen loading (in the form of dates and date bars) during 40 km time-trial performance in healthy adults. The suitability of dates and date bars as nutritional aids during the time trial were also be evaluated.

**Methods** Nine healthy and habitually active subjects (40.8 years  $\pm$  8.9, 178.2 cm  $\pm$  7.9, 75.4 kg  $\pm$  11.9 and 23.7 kg/m<sup>2</sup>) took part in five separate 40 km time trials over a 2 month period, a familiarisation trial, consuming no food (C) or 30 g equivalent of CHO in the form of dates (D) or date bars (DB) under normal conditions, and date bars under fasted conditions (DBF). All exercise tests were completed on a stationary cycle ergometer with pulmonary gas exchange and heart rate was measured throughout. The power output and time to complete the race distance were measured as outcome variables. The responses of oxygen uptake and carbon dioxide production were used to estimate total caloric expenditure and the percentage energy yield from carbohydrate and fat oxidation. Subjective ratings of perceived exertion was recorded and a post time trial questionnaire was also administered.

**Results** The basic indicators of performance (duration, power output) did not demonstrate any significant difference between the four experimental conditions. The total calorie expenditure was significantly higher ( $P < 0.05$ ) in C, D and DB compared to DBF. The rate of calorie expenditure during the final quarter was significantly higher ( $P < 0.05$ ) in C and D compared to DBF.

**Conclusions** No clear conclusions can be drawn from the quantitative data collected from this study. The key limitation of the study was the difficulty experienced by subjects to consume the test sample whilst cycling. However, the results do suggest that dates may be a good source of energy during higher intensity exercise, whilst date bars may be better suited to lower intensity exercise such as hillwalking. Despite the lack of conclusive results obtained from this study, it has highlighted a number of experimental design considerations that would be applied in future studies of a similar nature. Data collected from the post

sample questionnaire provided useful insight into the subject's positive perception of the samples on their performance.

## 2.5 Provision of Technical Information

In order to support claims made on the product packaging and marketing material, relevant information was collated. This included data to support nutrition claims (relating to mineral and fibre content), one of five a day claims, and glycaemic index claims.

- "Source of" nutrition claims

A "source of" mineral claim can be fulfilled when a serving of the date bars provides a minimum of 15 % of the NRV (nutrient reference value) supplied in the Annex of EU regulation 1924/2006. Mineral analysis carried out at Plymouth University provided the necessary data to support these product claims on the six date bars.

The following mineral claims can be made:

- Berry fruit and nut bar provides a source of phosphorus, magnesium, manganese and copper.
- Choc and mint provides a source of phosphorus, magnesium, manganese and copper.
- Choc and orange provides a source of manganese and copper.
- Double choc provides a source of phosphorus, magnesium, iron, manganese and copper.
- Mixed nuts fruit and nut bar provides a source of phosphorus, magnesium, manganese and copper.
- Cherry and maple fruit and nut bar provides a source of phosphorus, magnesium, manganese and copper.

A "source of fibre" claim can be fulfilled when a serving of the date bars provides a minimum of 3 g of fibre per 100 g of product, or at least 1.5 g fibre per 100 kcal. Nutritional data provided by suppliers was used to calculate the fibre content of the data bars. All the date bars provide a source of fibre.

- 1 of 5 a day claims

There is no EU legislation that regulates the use of "1 of 5 a day" (which refers to the number of fruit or vegetable servings per portion of food). Advice was sought from the NHS "5 A Day" website and the IGD document *Best Practice Guide to Calculating and Communicating Fruit and Vegetable Portions in Composite*

*Foods* (with specific reference to case study 5 in section 6) in order to assess whether the products fulfilled the requirements of this claim.

As a rule of thumb, a 30 g serving of dried or freeze dried fruit provides one serving of fruit, or the equivalent of 80 g fresh weight, which takes into account the degree of dehydration. Using a combination of these requirements, as well as portion advice from the NHS website, it was calculated that all bars except the double choc variant met the requirement.

- Glycaemic and satiety index claims

There is no EU legislation that regulates the use of “low GI” claims. However, the EU has declared that food products claiming a particular GI cannot infer further functionality (i.e. this product has a low GI and is therefore better/suitable for diabetics). Both bars tested in the glycaemic index testing had a low GI (<55). The remaining four variants will be evaluated in due course.

The use of satiety claims are not permitted under EU regulation unless authorisation has been given. In this instance, substantial evidence must be provided to the EU.

## 2.6 Product Launch

On 23<sup>rd</sup> and 24<sup>th</sup> September 2014, Good Full stop officially launched at the Lunch Expo in London. The bars received a large amount of interest and overwhelmingly positive feedback.



### 3. Rehydration Room Project

#### 3.1 Background

Date paste is one of the main products sold by Western Commodities Ltd. It is used by food manufacturers to produce a variety of products, including sauces, baked goods and date bars. When dates are pasted, the heat of the processes warms up the dates which produces a soft paste. However, as the paste cools down, it becomes hard and difficult to process by food manufacturers. Rehydrating the dates prior to pasting increases the moisture content and helps to ensure that the paste remains softer for longer after manufacture.

#### 3.2 Rehydration Trials

As a new process for Western Commodities Ltd., the variables that influence the end moisture content and water activity needed to be establish, namely the temperature and duration of the rehydrating process. Additional variables, such as volume of dates in the rehydration room, position of the pallet in the rehydration room and storage conditions post rehydration were also evaluated. Through a series of trials, vast amounts of data was collected on the moisture content and water activity of the dates prior to and after rehydration, as well as after pasting. The data was analysed to recommend the best rehydration conditions for each customer.

#### 3.3 Policies and Documentation

In adherence to BRC, appropriate controlled documents were drawn up to record the policies, procedures and data records, which have been implemented in the factory.

#### 4. References

Al-Farsi M., Alasalvar, C., Morris A., Baron M. and Shahidi F. (2005) Comparison of antioxidant activity, anthocyanins, carotenoids, and phenolics of three native fresh and sun-dried date (*Phoenix dactylifera* L.) varieties grown in Oman. *Journal of Agricultural and Food Chemistry*, **53**:7592–7599

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