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Chemical Composition, Fatty Acids Content and Glycemic Index of Two Different Types of Omani Halwa

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Abstract: The study evaluated the chemical composition, fatty acids contents and Glycemic Index (GI) of two different types (white and black) of Omani halwa. Representative samples of Omani halwa were collected from the local market. The proximate composition and energy contents of white and black halwa did not vary significantly (p<0.05). The percentage moisture, crude protein, total fat, ash, crude fiber and Nitrogen Free Extract (NFE) in white and black halwa were 11.8 and 12.1; 0.28 and 0.44; 13.8 and 12.4; 0.01 and 0.02; 0.15 and 0.05 and 74.0 and 75.0, respectively. The energy values in white and black halwa were 421.3 and 413.4 kcal/100 g, respectively. No significant (p<0.05) differences were observed in the total fatty acids, Saturated Fatty Acids (SFA), Monounsaturated Fatty Acids (MUFA) and Polyunsaturated Fatty Acids (PUFA) content in both types of Omani halwa. The SFA were present in highest concentration. The proportionate percentages of SFA, MUFA and PUFA in white and black halwa were 64.57, 65.47, 31.28, 30.79, 4.11 and 3.74%, respectively. The average GI and GL values for white and black halwa also did not vary (p<0.05) and were 54.8 and 52.0 and 14 and 13.4, respectively. Although the glycemic index values of Omani halwa fall in low GI category (<55), it should be consumed with caution because of its high fat, in particular of SFA and high sugar contents.

Key words: Omani halwa, proximate composition, fatty acids, glycemic index

INTRODUCTION

The people have passion for sweets globally and every nation/culture has its own traditional sweet dishes that are not only served on special ceremonies/occasions but are also used as a gesture of hospitality in everyday life. Omani halwa is one such example that is not only a traditional sweet-dish from Oman but is also a favorite in the Gulf region and in the Arab world. The history of Omani halwa is well knitted in the social/cultural structure of the local people and has become a key to Omani hospitality when served with Omani coffee. Oman lies in the South-Eastern part of Arabian Peninsula and represents a fine mix of ancient society and modern lifestyle. Drastic changes have occurred in the recent past in the lifestyle and food consumption patterns of the people as the people have shifted to consume more energy-dense ready-made fast foods including the sweets and savoury snack foods (Musaiger and Miladi, 1995; Ali *et al*., 2013). These changes have brought a major shift in health related problems from the survival issues to so-called nutrition related non-communicable diseases of affluence such as obesity, diabetes, hypertension and heart diseases. The results of the National Health Survey have shown that the prevalence of diabetes, impaired glucose tolerance, hypertension, hypercholesterolemia and obesity is high in Oman (Al-Riyami *et al*., 2000). The prevalence of these conditions is higher in urban areas, in particular in older people than the rural population (Al-Moosa *et al*., 2006). The existence of metabolic syndrome in Oman has also been reported to be comparable to developed countries (Al-Lawati *et al*., 2003). In a recent study we reported that obesity, high daily caloric intake, in particular higher consumption of refined carbohydrates and protein were associated with increased risk of Non-Hodgkin's Lymphoma (NHL) in Oman (Ali *et al*., 2013). It has been suggested that chronic diseases will continue to drain Oman's human and financial resources, if appropriate strategies are not developed and introduced to current health care system (Al-Lawati *et al*., 2008).

The Omani halwa is a high energy-dense food that consists mainly of fat, starch and sugar. Sweet dishes containing high fat and high sugar are more palatable and are therefore usually overeaten and may lead to overweight and obesity (Rolls and Hammer, 1995). Only limited information is available on the chemical composition of commonly consumed traditional Omani foods and mixed dishes, including Omani halwa

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(Musaiger *et al.*, 1998). Data on the nutrient composition of traditional foods is not only crucial to assess the daily dietary intakes of the local people but also for meal planning to meet the nutrient requirements as well as in the prevention and control of various diet-related diseases. The diet-analysis software which are mostly available in the market to estimate the energy and nutrient intake of individuals, lack the nutrient-composition data about the locally consumed traditional foods. The databank on the nutrient composition of foods in these software's is therefore required to be updated with the actual nutrient-composition of traditional local foods. The modified diet-analysis software can then be used to estimate the nutrient requirements and develop meal plans including the traditional local foods for the local people.

In our previous studies we reported about the chemical composition and glycemic index of different types of traditional Omani breads (Ali *et al.*, 2010) and date fruits (Ali *et al.*, 2009) consumed in Oman. The Glycemic Index (GI) of foods is a numeric physiologic system of classifying the carbohydrate rich foods that ranks foods on a scale from 0-100 based on their potential how quickly they are digested, absorbed and raise the blood glucose level as compared to a standard food (Jenkins *et al.*, 1981; FAO/WHO, 1998). Consumption of low glycemic index foods has been shown to have long term beneficial effects on health (Jenkins *et al.*, 2002; Brand-Miller *et al.*, 2009; Chiu *et al.*, 2011). Data on the chemical composition and Glycemic Index (GI) values of local and traditional foods is therefore essential in daily meal planning and to make appropriate dietary recommendations for the people. There is a paucity of information on the nutritional quality, chemical composition and glycemic index of various types of Omani halwa. The present study was therefore conducted to determine the proximate composition, fatty acids content and glycemic index of two different types (white and black) of Omani halwa.

MATERIALS AND METHODS

Determination of chemical composition: Representative samples of white and black Omani halwa were collected from the local market in Muscat, Oman. The Omani halwa is prepared conferring to the centuries old traditional methods which are normally passed on from one generation to another and are kept as trade secret within the family. The main ingredients of Omani halwa include butter oil, starch, sugar, water, nuts, saffron, cardamom, rose water and sometimes colours or flavours. The general process of preparation is by adding sugar to the boiling water with continuous stirring and then starch is added to it while the stirring process continues until the mixture starts becoming gelatinous. The butter oil (ghee) is then added and stirring is continued until it turns into a thick jelly like substance. At this stage rose water, saffron, cardamom, granulated almonds and/or walnuts are added according to the type of halwa. At the end of cooking process, the surface is decorated with almonds and/or walnuts. Some other ingredients may also be used according to the good manufacturing practices as described by the Ministry of Commerce and Industry in Omani Standards for the Preparation of Halwa [Ministry of Commerce and Idustry (MCI), 2004].

The proximate composition (moisture, ash, crude fiber, crude protein and total fat contents) of the representative samples of Omani halwa was determined according to the methods of Association of Official Analytical Chemists (AOAC, 2000). The Nitrogen Free Extract (NFE) was calculated by difference (100 minus percentages of moisture, crude protein, total fat, ash and crude fibre). The values for the proximate analysis are expressed as g per 100 g of halwa. The energy value (kcal/100 g) of halwa was calculated by multiplying the amount of carbohydrates, protein and fat contents in grams with 4, 4 and 9 respectively as described by Ali *et al.* (2009).

Determination of fatty acids composition: The fatty acids composition of halwa was determined using the gas chromatograph model "AGILENT 6890-N" (Bellefonte, PA, USA). A fused capillary column attached with a flame ionization detector was used for the analysis of fatty acids. The column (SUPLECO SP-2380) was 30 m long having an internal diameter of 0.25 mm and 0.20 µm of film thickness (SUPLECO Inc., Santa Clara, CA, USA). The helium gas was used as carrier gas. The standard operating conditions for the analysis of fatty acids as given in the operating manual of the equipment were followed. The extraction of the fatty acids as methyl esters was carried out as described by the methods of AOAC (2000). An Agilent 7683 series injector was used to inject the extracts for fatty acids analysis which were identified by comparing their retention time with a commercially available standard mixture of 37 components of FAME Mix Standard (SUPLECO Inc., Santa Clara, CA, USA). The quantification of fatty acids was done by using heneicosanoic acid (C21:0) methyl ester as an internal standard and the results were calculated as g per 100 g of halwa.

Determination of Glycemic Index (GI): The glycemic index of Omani halwa was determined in normal healthy human volunteers as described by Wolever *et al.* (1991) and FAO/WHO (1998). The recommendations of American Diabetic Association (ADA) were followed for the inclusion criteria for volunteers. The volunteers had the normal fasting blood glucose levels and did not show any impairment in oral glucose tolerance test to rule out the diabetes (ADA, 2006). Each volunteer was required to read a written explanation of the study protocol and signed an informed consent. The volunteers were allowed to ask any question in order to have a clear idea about the experiment. Glucose was used as a standard reference food. Ten normal healthy human volunteers (undergraduate students from Sultan Qaboos University, including both males and females) were recruited for this study. The average age and Body Mass Index (BMI, kg/m^2) of the volunteers were 22±0.9 years and 22.7±2.2, respectively. The mean body weight of the volunteers was 60.3±10.5 kg. The volunteers were asked to report in the laboratory at 7:45 am after an overnight fast of 12 hours for glycemic index testing. The subjects were given the portions of test food and standard reference food (glucose) containing 50g of available carbohydrates in random order on separate occasions with 250 mL of water. The glycemic index testing protocol as described by Ali *et al*. (2009) was followed. A drop of capillary blood, obtained by finger prick method, was used for measuring the blood glucose level. A SureStep Brand Professional Blood Glucose Meter (Johnson and Johnson Company, USA) was used to measure the blood glucose level. The glycemic index was calculated using the incremental area under the blood glucose response cure (IAUC) for the test food compared with the IAUC for the reference food taken by the same subject at 0 (fasting), 15, 30, 45, 60, 90, 180 minutes after the ingestion of food. The GI = (IAUC of test food ÷ IAUC of standard food)*100 (Wolever *et al*., 1991; FAO/WHO, 1998).

Statistical analysis: The data obtained was analyzed statistically using descriptive statistics. The results are expressed as means±standard deviation (SD). The means were compared by using Student's t-test as described by Snedecor and Cochran (1989). The ethical approval of the study protocol was obtained from the Research in Ethics Committee of Sultan Qaboos University, Muscat, Oman.

RESULTS AND DISCUSSION

The proximate chemical composition of Omani halwa: The proximate composition of Omani halwa is shown in Table 1. No significant ($p<0.05$) differences were observed in the proximate composition and energy content of white and black Omani halwa. The values for percentage moisture, crude protein, total fat, ash, crude fiber and Nitrogen Free Extract (NFE) in white and black halwa were 11.81 and 12.13, 0.28 and 0.44, 13.84 and 12.94, 0.68 and 0.57, 0.15 and 0.27, 73.24 and 73.65, respectively. The energy values in white and black halwa were 418.6 and 403.8 kcal/100 g respectively. Musaiger *et al*. (1998) however reported higher percentages of fat (17.95%) and a little lower percentage of carbohydrate (71.2%) in samples of Omani halwa and as a result higher energy value (446.5 kcal/100 g) as compared to our results. This may be due to the variability in ingredient composition used in the preparation of various types of Omani halwa available in the local market. The main constituents in Omani halwa as indicated by proximate composition are carbohydrate and lipids. Rahman *et al*. (2012) reported that the patterns of Texture Profile Analysis (TPA) attributes of Omani halwa were mostly linked to its moisture and fat content. The moisture and sugar contents were significantly correlated with hardness whereas the moisture and fat contents affected the firmness and chewiness characteristics of Omani halwa (Rahman *et al*., 2012).

Fatty acids composition of Omani halwa: Table 2 gives the fatty acid composition of white and black Omani halwa. Some of the individual fatty acids in white and black halwa varied significantly ($p<0.05$). However, the overall total amount of fatty acids observed in white and black halwa did not differ ($p>0.05$). Similarly the proportionate percentage of Saturated Fatty Acids (SFA), Monounsaturated Fatty Acids (MUFA) and Polyunsaturated Fatty Acids (PUFA) in white and black halwa also did not differ significantly ($p>0.05$). The highest concentration of fatty acids was SFA. The proportionate percentages of SFA in white and black halwa were 64.57 and 65.47%, respectively. The main SFA found in white and black halwa were capric acid (C10:0), lauric acid (C12:0), myristic acids (C14:0), palmitic acid (C16:0) and stearic acid (C18:0), whereas the main MUFA was oleic acid (C18:1). The proportionate percentages of MUFA in white and black halwa were found to be 31.28 and 30.79%, respectively. The PUFA were found in the lowest concentrations. The higher amounts of SFA present in the white and black Omani halwa is considered to be due to its butter oil (ghee) content that is used in its preparation. The butter oil (ghee) mainly contains saturated fatty acids (Glew *et al*., 1999; Dixit and Das, 2012). The specific types of fatty acids in Omani halwa have been reported to be significantly correlated with its all Texture Profile Analysis (TPA) attributes (Rahman *et al*., 2012). Small amounts of Trans-Fatty Acid (TFA) (Elaidic acid, C18:1-t and Linolelaidic acid, C18:2-t) were also found to be present in Omani halwa. Traces of TFA have been reported to exist naturally in plant oils as well as in meat, milk and dairy products (Ohnishi and Thompson, 1991; Kliem *et al*., 2013). The presence of small quantities of TFA

Table 1: Proximate chemical composition (%) and energy value (kcal/ 100g) of Omani halwa

Type of food/ parameter	Moisture	Crude protein	Total fat	Ash	Crude fibre	NFE	Energy (kcal/100 g)
White halwa	11.81±0.9	0.28±0.1	13.84±1.1	0.68±0.1	0.15±0.1	73.24±1.5	418.6±8.9^{NS}
Black halwa	12.13±0.7	0.44±0.1	12.94±0.9	0.57±0.1	0.27±0.1	73.65±1.9	403.8±10.3^{NS}

NS: non-significant

Table 2: The average fatty acids composition of White and Black Halwa (g/100 g of halwa)

	Mean±SD	
Fatty acid	White halwa	Black halwa
C4:0 (Butyric)	0.098±0.034	0.069±0.029
C6:0 (Caproic)	0.154±0.057	0.130±0.005
C8:0 (Caprylic)	0.114±0.045	0.109±0.049
C10:0 (Capric)	0.334±0.099	0.450±0.085
C11:0 (Undecanoic)	0.065±0.002	0.035±0.004
C12:0 (Lauric)	0.514±0.090	0.739±0.065
C13:0 (Tridecanoic)	0.011±0.004	0.017±0.004
C14:0 (Myristic)	1.438±0.057	1.742±0.218
C14:1 (Myristoleic)	0.095±0.060	0.049±0.015
C15:0 (Pentdecanoic)	0.192±0.051	0.267±0.040
C15:1 (Cis-10-pentadecanoic)	0.131±0.073	0.158±0.069
C16:0 (Palmitic)	1.369±0.066	1.281±0.104
C16:1 (Palmitoleic)	0.352±0.059	0.242±0.025
C17:0 (heptadecanoic)	0.089±0.015	0.103±0.101
C17:1 (Cis-10-Heptadecanoic)	0.086±0.056	0.188±0.029
C18:0 (Stearic)	1.189±0.165	0.983±0.111
C18:1 (Oleic)	1.848±0.269	1.961±0.329
C18:1 (Elaidic) trans-fat	0.031±0.009	0.036±0.006
C18:2 (Linoleic)	0.093±0.044	0.075±0.010
C18:2 (Linolelaidic) trans fat	0.019±0.001	0.017±0.001
C18:3 (γ-linolenic)	0.011±0.005	0.004±0.001
C18:3 (α-linolenic)	0.126±0.043	0.158±0.035
C20:0 (Arachidic)	0.173±0.022	0.219±0.026
C20:2 (Cis-11, 14-Ecosadienoic)	0.009±0.002	0.010±0.002
C20:3)Cis-11, 14, 17 Eicosatrienoic)	0.013±0.005	0.015±0.006
C20:4 (Arachidonic)	0.008±0.001	0.008±0.001
C20:5 (Cis-5, 8, 11, 14, 17-Eicosapentaenoic)	0.011±0.005	0.013±0.005
C21:0 (Henicosanoic)	0.079±0.093	0.152±0.049
C22:0 (behenic)	0.014±0.004	0.017±0.001
C22:6 (Cis-4, 7, 10, 13, 16, 19-Docosahexaenoic)	0.002±0.001	0.003±0.001
C23:0 (Tricosanoic)	0.005±0.002	0.006±0.001
C24:0 (Lignoceric)	0.010±0.004	0.013±0.006
C24:1 (Nervonic)	0.005±0.002	0.003±0.002
Total Fatty acids	9.054±0.443^{NS}	9.667±1.059^{NS}
Total Saturated fatty acids (SFA)	5.847±0.318^{NS} (64.57%)*	6.329±0.379^{NS} (65.47%)*
Total Monounsaturated fatty acids (MUFA)	2.832±0.169^{NS} (31.28%)*	2.976±0.181^{NS} (30.79%)
Total Polyunsaturated fatty acids (PUFA)	0.372±0.089^{NS} (4.11%)*	0.362±0.085^{NS} (3.74%)*

* = Proportionate %age of SFA, MUFA and PUFA of the total fatty acids
NS = non-significant

in Omani halwa (<0.5 g/100g of lipids) may be due to its ingredient composition as well as to the preparation process, as one of the major ingredients is the butter oil. This amount is however much less than the permissible standard limits for TFA in food products. Almar *et al.* (2013) reported that the TFA content in most of the tested Malaysian foods such as bakery products, snacks, dairy products, fast foods and breakfast cereals was <1 g/100 g of lipids. Saturated fats and trans-fats have been shown to be associated with higher risk of coronary heart diseases and therefore their dietary intake should be restricted within the recommended limits (WHO, 2003; Muzaffarian *et al.*, 2009; Mashal *et al.*, 2012). It has been recommended that dietary intake of TFA should be less than 1% of daily total energy intake (WHO, 2003). Takeuchi *et al.* (2013) showed that consuming TFA at less than 1% of total daily energy intake had little effect on serum cholesterol and glycated hemoglobin (HbA1c) levels in healthy young Japanese women.

Glycemic index of omani halwa: On the average the volunteers had normal fasting blood glucose values (96±2 mg/dL) and also did not show any impaired fasting blood glucose (IFG) responses. The glycemic responses of the volunteers for the standard reference food (glucose) and Omani halwa are shown in Fig. 1. The pattern of glycemic responses for both types of Omani halwa was very much similar. The ingestion of halwa didn't drastically increase the glycemic response. The results for Glycemic Index (GI) and Glycemic Load (GL) values of white and black halwa are presented in Table 3. Although the white halwa showed a little higher glycemic index value (54.8±15.3) as compared to black

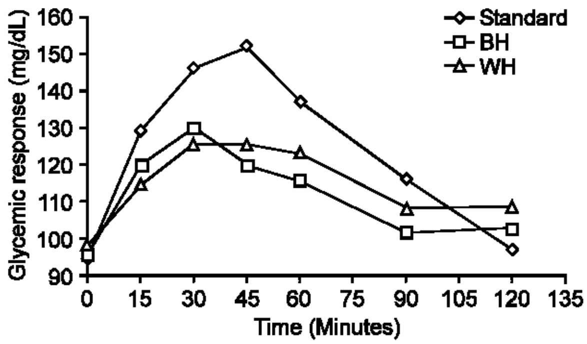

Fig. 1: The average glycemic response of volunteers on standard reference food (glucose) and test food (Omani halwa)

Table 3: The average glycemic index of white and black Omani halwa

	Mean±SD	
Type of food/parameter	GI	GL*
White halwa	54.8±15.3^{NS}	14.0±1.3^{NS}
Black halwa	52.0±16.5^{NS}	13.4±1.5^{NS}

GI: Glycemic Index, GL: Glycemic Load. *The serving size of halwa is assumed to be as 35 g. The available carbohydrate (CHO) in one serving of white and black Omani halwa is calculated to be 25.6 and 25.8 g, respectively. GL = (GI x available CHO per serving)/100

halwa (52.0±16.5), the difference was not statistically significant (p<0.05). The glycemic index values for both types of Omani halwa fall in the low glycemic index category (<55.0) of foods (Foster-Powell *et al.*, 2002; Brand-Miller *et al.*, 2003). The similar low GI values for both types of Omani halwa could be due to a number of factors mainly because the same type of ingredients and similar processing method is used in the preparation of both types of halwa. The only difference is the type of sugar used which is of red colour in case of black halwa and white in case of white halwa. However, the reason for the low GI values of these Omani halwa cannot be exactly explained. A number of variables including both the food and physiologic factors may influence the absolute amount of postprandial blood glucose after the digestion and absorption of nutrients from the foods (Pi-Suneyer, 2002; Brouns *et al.*, 2005; Aziz, 2009). The physical form of the food molecules, nature of monosaccharide and starch, the way of cooking and degree of processing, as well as the amount and type of other food components present can influence the GI values of foods (Monge *et al.*, 1990; Brouns *et al.*, 2005; Parada and Aguilera, 2011). The lower GI values of Omani halwa tested in this study may be attributed to the way it is processed with a lot of butter oil, sugar and starch. The preparation process may result in the production of more compact starch granules which give it the gelatinous structure that might result in slow release of glucose after digestion. The food products containing similar amounts of starch can have different postprandial blood glucose responses which may be due to the composition and structure of food as well as due to the simultaneous ingestion of other food components (Parada and Aguilera, 2011). The high fat content of halwa might also have played a role in delaying the gastric emptying time which may also have tended to flatten the glycemic response curve (Collier *et al.*, 1983; Gannon *et al.*, 1993; Foster-Powell *et al.*, 2002).

The GL values for white and black halwa (14.0±1.3 and 13.4±1.5, respectively) also didn't vary significantly (p<0.05). The glycemic load of a food is defined as a function of the amount of carbohydrate intake per serving and the glycemic index of that food. One unit of GL approximate the glycemic effect of 1 gram of glucose. The serving size of Omani halwa is assumed to be 35 g that contained 25.6 and 25.8 g of available carbohydrate in one serving respectively. The GL values for white and black halwa fall within the medium glycemic load category (Foster-Powell *et al.*, 2002; Brand-Miller *et al.*, 2003). Data from various epidemiological and interventional studies has revealed that lower GI foods and GL diets may have positive effects on the appetite and food intake and can help to improve the glycemic control without compromising hypoglycemic events. Low GI foods have shown many beneficial effects in controlling a wide range of pathophysiological conditions such as diabetes, cardiovascular disease, obesity and certain forms of cancer (Alfenas and Mattes, 2005; Barclay *et al.*, 2008; Chiu *et al.*, 2011; Fleming and Godwin, 2013; Rouhani *et al.*, 2013; Schwingshackl and Hoffmann, 2013). The results from some other randomized controlled trials however suggest that low GI and GL diets have inconsistent effects on CVD risk factors (Kristo *et al.*, 2013). More studies are therefore required to further elucidate and interpret the results.

The excessive consumption of energy-dense foods containing added sugar and lipids is considered as the leading cause of obesity and cardiovascular diseases worldwide. Higher consumption of such foods may not only lead to some essential nutrient deficiencies but has also been associated with many metabolic abnormalities and poor health conditions (Johnson *et al.*, 2009; Britton *et al.*, 2012). The updated US Department of Agriculture (USDA) Food Patterns after considering the 2010-US Dietary Guidelines for Americans have identified more healthful foods choices and recommend that the people should meet their daily nutrient needs by consuming a variety of nutrient-dense foods. By consuming nutrient-dense foods, the people can meet their daily nutrient requirements within their daily energy allowance and can have limited amounts of foods containing solid fats and added sugars (8-19% of calories) in their daily meal plan (Britton *et al*., 2012). Although the Omani halwa showed low GI values, it is an energy-dense food that contains high amounts of butter oil and added sugars. Therefore only small quantities should be consumed within the recommended daily dietary energy intake level as a part of a varied diet containing other nutrient-dense foods. Majority of the people do not show dietary self-efficacy and self-management behaviours in their diabetes control and do not meet the recommended goals for diabetes care (Al-Khawaldeh *et al*., 2012; Ali *et al*., 2013). It is therefore important to develop appropriate educational strategies and awareness campaigns to educate the people in promoting the self-management behaviours for making healthy food choices to control their dietary intake and lifestyle behaviours in the prevention of non-communicable diseases.

Conclusion: Omani halwa is an important traditional food that is served in Omani homes together with Arabian coffee as a part of culture. It is served both at times of joy and sorrow, on religious occasions and on festivals as a symbol of hospitality. The main components in Omani halwa are butter oil (ghee), sugar and starch that make it a highly energy-dense food. The proximate chemical composition, fatty acids contents, energy value, glycemic index and glycemic load in both types (white and black) of Omani halwa did not differ significantly. The average glycemic index values of white and black halwa (52.0 and 54.8, respectively) fall within low glycemic index category whereas the glycemic load values (14.0 and 13.4, respectively) fall in the medium category. We are reporting for the first time about the GI and GL values for Omani halwa. Although GI values of Omani halwa were found to be low, it is suggested that keeping in view its high energy-density and higher concentration of SFA, only small quantities should be consumed within the recommended daily dietary energy intake allowance as a part of a varied diet. Such data is of primary significance in developing the appropriate dietary management strategies in daily meal planning to reduce the risk of chronic diseases.

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